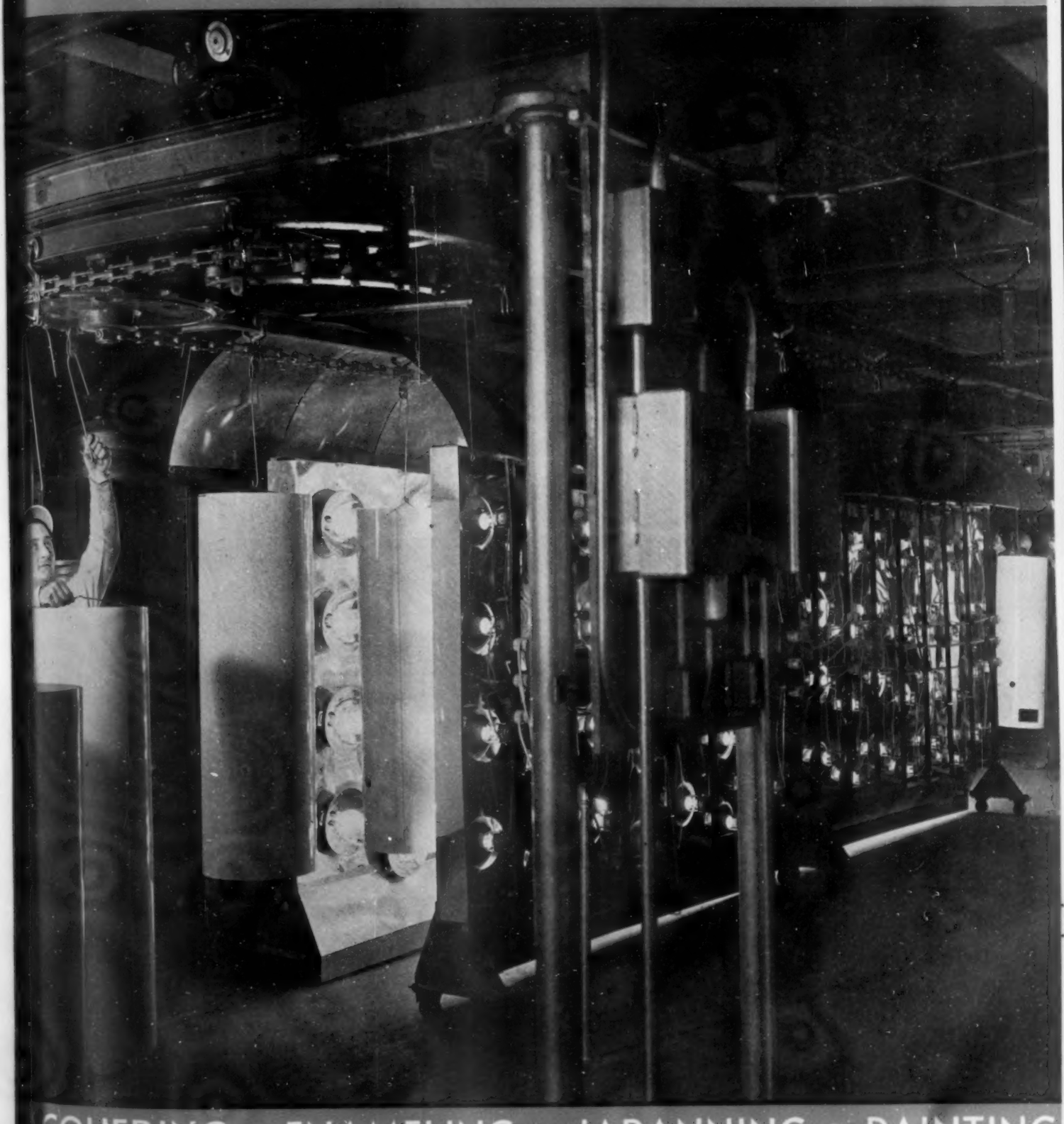
MARCH, 1942

ORGANIC FINISHING

SECTION OF METAL FINISHING



CQUERING • ENAMELING • JAPANNING • PAINTING

NOTICE

The supply of many of our essential raw materials has been definitely curtailed. A further reduction of the supply of these raw materials is to be expected over the coming months. Other raw materials and supplies, now available in quantity, will surely be added to the restricted list.

THIS MEANS THAT THE PRODUCTION OF THIS PLANT WILL BE DEPENDENT ON THE AMOUNT AND KIND OF RAW MATERIALS WHICH WE CAN OBTAIN RATHER THAN ON THE DEMAND FOR THE PRODUCTS WE MAKE.

It is therefore obvious that it is to the interest of every employee to do his utmost to avoid the waste of every kind of raw material we use.

You can cooperate by avoiding spoilage, producing the maximum possible percentage of first class goods, reporting leaks, eliminating spillage, and avoid waste by keeping the usage of ALL kinds of supplies and materials to a minimum.

M. J. Creighton
GENERAL MANAGER

THIS recent bulletin board notice put the whole matter so well that we thought the G.M. had written a mighty good advertisement. Shortages and reductions in materials face us, but conservation and elimination of waste will help to keep us all busy.

ZAPON
ZAPON DIVISION · ATLAS POWDER COMPANY
Eastern Sales: Stamford, Conn. Western Sales: North Chicago, Ill.
INDUSTRIAL FINISHES

Section of

METAL FINISHING

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ORGANIC FINISHING

SECTION OF METAL FINISHING

MARCH, 1942

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Toluol

Toluol, the aromatic solvent used generally in lacquer thinners and reducers for synthetic enamels, was placed under full priority control on August 28, 1941, under Order M-34. On February 1st of this year, it was placed under full allocation, and use of toluol as a diluent for protective coatings was entirely prohibited on February 1st. The reason for the extreme shortage is that large demands have been made for this material for the production of nitrated derivatives for explosives. Only a fraction of our requirements of toluol are produced in the recovery from by-products of coke operations even though these operations have reached a peak. Immense strides have been made in the obtaining of toluol from petroleum and it is estimated that some 70% of the present 100,000,000 gallons annually produced from plants now operating will be derived from petroleum and there is some discussion of increasing the capacity to 200,000,000 gallons.

The principal methods for the production of toluol from petroleum are the extractive and the catalytic processes. One plant alone using the catalytic method has a production of nearly 30,000,000 gallons annually.

The banning of toluol as a diluent in finishing materials has vastly increased the demands for xylol, thus creating a shortage for xylol. Fortunately, the trend towards greater use of synthetic finishing materials has enabled the use of hydrogenated solvents to replace all or part of the toluol or xylol formerly used. Due to the hydrogenated naphthas having lower dilution ratios for nitrocellulose than do toluol or xylol, their use in nitrocellulose type finishes usually requires that a greater percentage of nitrocellulose solvent be employed, and unfortunately, these solvents are also in a short condition.

L. H. LANGDON, *Publisher* • T. A. TRUMBOUR, *Business Manager* • DR. WALTER R. MEYER, *Editor*

Fewer But Better Finishes

A. L. PIPPER
Manager, Manufacturing Service Division
RCA Manufacturing Company, Inc.,
Camden, N. J.

Introduction

THE business of the RCA Manufacturing Company is complex, ranging as it does from the manufacture of a tiny lapel microphone to a complete complement of equipment for a broadcasting station. Our standardization program, therefore, also represents a complicated problem.

Standardization as a regular part of RCA company procedure first received attention in Camden in the spring of 1935. The all-important factor of management interest in standardization was taken care of in our company in a definite manner. Our management is solidly behind standardization.

Our first operations were conducted as a committee activity with representation from engineering, manufacturing, and purchasing. After a few months, the results were so favorable that standardization was established as a separate and independent division with an adequate staff.

We now issue and maintain about 125 sets of Standardizing Notices throughout our various departments and manufacturing plants. All volumes are listed as the property of the Standardizing Division and are subject to recall. We require a receipt from each recipient of new issues at the time of issue. This was done to insure proper maintenance of the data. We require that superseded sheets be returned to the Standardizing Division for disposal. This is also done to guard against the danger of keeping obsolete sheets in file with notices which are current.

Standardizing Finishes

Finishing is the most expensive single operation in our plant if improperly done.

No matter how well we have done the job of engineering and manufacturing, the first appeal to the customer is what he sees when he opens the package. A piece of equipment that is scientifically correct and is made to a high standard of manufacturing quality may still produce a dissatisfied customer if the finish is bad.

Prior to standardization, our finishes were designated by name and by number. The numbers consisted of digits followed by letters to indicate revisions or similarities, or both.

Two elements in this system caused us some concern. First, use of digits followed by letters, for example, 12 and 12A, was too dangerous. It was too easy to omit the letter and get the wrong finish. Second, a factor which operated against letter designations in our case was the difficulty of transposing letters into numerals in Accounting Department for use with tabulating equipment.

As a result, we adopted a three-digit system, which gave us 999 numbers to use. After five years, we still have spare numbers.

We then cross-indexed the old to fit the new so that we would not have confusion in drawings already existent; for example, 12 became 120; 12A become 121; 12B became 122, and so on.

At the end of three years, the system was so well implanted that the cross-index feature was no longer needed to guide our people.

We then started to eliminate the identification of material by the name of the manufacturer. We found that each manufacturer had his own designation for his materials. We might have a stock of John Doe Company, Black Lacquer #45789 and also some XYZ Company, Black Lacquer #A-7899 which was the equivalent of the other. If the job in question started with John Doe #45789, the odds were that it would continue throughout and more material might be purchased even though a stock of XYZ Black Lacquer, #A-7899 was actually on hand.

This problem was not easy to solve. We did it this way:—First we eliminated all reference to the manufacturer in our Standardizing Notices and spoke only of "Finish Number ——." Next we requested that all samples and all production quantities be marked with our number by the manufacturer. We did not object to his number appearing so long as "RCA #——" also appeared on the container.

In cooperation with our purchasing department, arrangements were made that all requests for samples of new finishes would clear through the Standardizing Division before any action was taken.

Please note that we put no restriction on who asked for samples. We are a large company and many sections have matters of finish to consider. To say that new materials could be ordered only by the Standardizing Division would have impeded progress and probably defeated the program we had in mind.

We also found we had the normal condition of departmental preferences for material from a specific manufacturer. This is always a factor. If the foreman is getting good results from a certain material he is likely to feel that the material then on hand is the essential element. Our problem was to break down that feeling, but we knew that when we did we must also give the foreman a material he could use to produce in accordance with his quality limits and his production schedules.

We also found it impossible to transfer information by words either spoken or written. Such terms as "light blue" or "glossy black" or

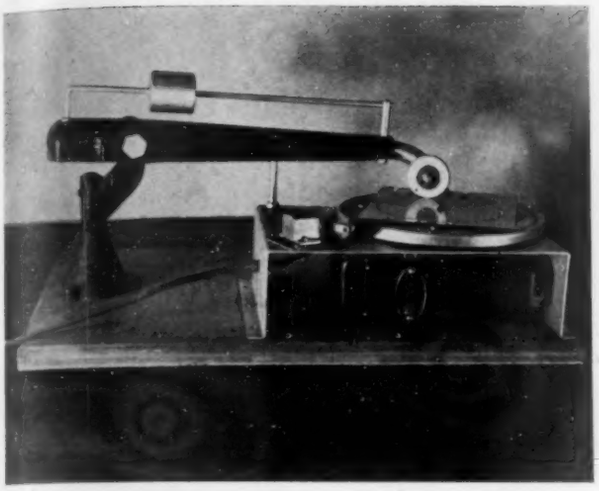


Fig. 1. A circular rubber eraser on a turntable is used to test the abrasion resistance of a finish.

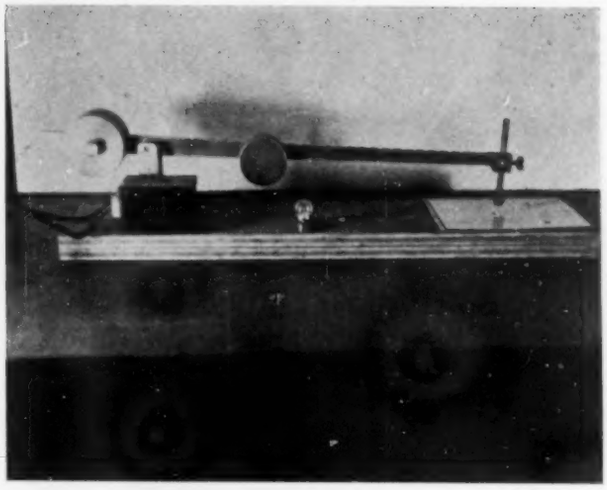


Fig. 2. A phonograph needle determines how hard a finish is. The weight on the arm is moved forward notch by notch until the needle pierces the finish.

"Modérne Brown" seem to create a different mental picture in everyone's mind.

In view of these findings our index system was inadequate and, to some extent, dangerous. For that reason we adopted a new system of three digits and issued a cross index to cover the matter of drawings and parts already in existence. This avoided the correction and re-issue of old drawings.

We had too many finishes but too few of us knew it, so we made some steel panels (we call them "Finish Chips") and made an actual specimen of every finish on our list. Then we called together the proper people from sales, styling, engineering, and manufacturing to decide, with us, on what we wanted to keep and what was superfluous.

We found that many items could be canceled outright. In many other cases, we found that we could eliminate one finish and take care of the problem with one we retained. As an example, we had nine different specifications for "black". We recognize there are shades of black but nine were too many. We now have three.

As everyone knows, descriptive terms do not adequately describe color. If I say "we have a standard brown", you will naturally want to know "What shade of brown?"

So we devised a wall cabinet, slotted to hold our regular 3 x 5 panel or finish chip. These cabinets were provided for each section where the question of finish for merchandise is determined. Each cabinet contains a sample of every standard finish. The Standardizing Division maintains the cabinets and keeps them up to date.

Now, the stylist, or the sales manager, or the engineer can decide by actual visual observation whether or not a standard finish, already existent, will be adequate for the job he has in mind. If the standard is adequate, he merely turns it over and specifies "RCA Finish #——" from the identifying number. If his job can not be handled with an existing standard, he calls in Standardizing and we take over the problem.

Next, we found that our processes were not sufficiently definite. We said "clean" but we didn't always say "how clean and with what cleaner". We said "reduce with thinner" but not always with what thinner.

This meant the preparation of Notices which are complete processes in themselves. Every step of the process is given. These processes which are complete in themselves are made the subject of a separate Notice and are referred to in the individual notices.

Quality Determination

We did not have an adequate system of determining the quality of a given material *before* it was applied to the work. The methods and equipment we were able to find seemed to us to be too complicated and elaborate for our use. It seemed to us that we must evolve, by trial and error, a method which gave us adequate information and was fair to the product of all manufacturers.

The procedure we devised to correct this situation is as follows:

Viscosity

We use a viscosimeter for determining the correct spraying viscosities for production spraying and for testing of finishing materials.

Materials are reduced to *standard* viscosities as specified by Standard Finish Notices for the type of spraying to be done.

Tests

We have four standard tests which we use to determine the acceptability of a finish:

1. Abrasion
2. Scratch Hardness
3. Flexibility—Adhesion
4. Coverage and Seconds per Square Foot to Spray

1. Abrasion Test

This test is used to determine the abrasion resistance of the finish. Conditions such as sliding a finished part from one assembly operation to another on the finish surface, sliding a finished part in and out of assembly fixtures, or the abrasive action of the packing paper during shipment of the finished product, all make it especially important that our finishes show a high degree of abrasion resistance.

The abrasion test is conducted on the RCA standard abrasion machine which consists of a turntable that revolves at 78 to 80 rpm.

Mounted at 15 degrees off center and supported by a balanced arm is a circular rubber eraser of the type generally used by stenographers. The test panel, which has been sprayed with

Fig. 3. Cabinet containing standard finishes.

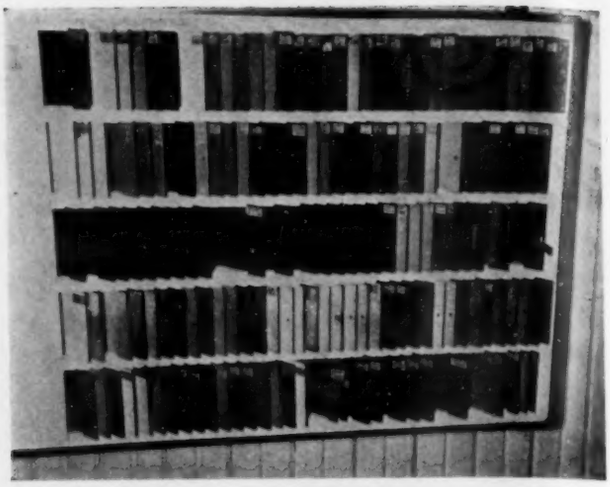


Fig. 4. Interior of cabinet showing rangement of standard finish panels.

the finishing material being tested, is placed on the turntable with the finish side up.

We adjust the rubber eraser so that it revolves easily. The angle wiping action of the eraser wears away the film being tested, and allows the eraser to be self-cleaning.

The arm which holds the eraser is balanced so that a pressure of four ounces is obtained at the eraser by moving the weight located on the eraser-supporting arm. When the correct pressure is obtained at the eraser, the weight is locked in place with a thumb screw.

As the panel revolves, the eraser wears the finish and a circle shows where the finishing material is removed. For air drying finishes, the following table is used:

Up to 200 revolutions	=	poor
200 to 300 "	=	fair
300 to 400 "	=	good
400 to 500 "	=	very good
500 and over "	=	excellent

If an unusual number of revolutions is recorded, it may indicate a very heavy film thickness and this will reflect in a lower coverage per gallon of material.

For baked finishes, the following table is used:

Up to 1000 revolutions	=	poor
1000 to 1500 "	=	fair
1500 to 2000 "	=	good
2000 and over "	=	excellent

This test is stopped when 2000 revolutions have been reached.

2. Scratch Hardness Test

This test is used to determine the hardness of a finish. Finishes that are too hard have a tendency to be brittle and can not stand shock or blows without chipping. Finishes that are too soft mar easily and can not stand packing or abuse without showing print marks of the packing.

The equipment used consists of a counter-balanced arm and pressure weight. On one end of the balanced beam is a phonograph needle. The beam is notched and as the weight is moved towards the needle it increases the weight on the needle until it pierces the film being tested.

The test panel is placed under the needle and drawn towards the operator. The weight on the beam should be moved forward one notch at a time and the panel observed after each forward movement until the film is pierced.

When the film is pierced the needle will complete an electric circuit to turn on a light. We check the needle frequently to see that it is sharp and we change it when necessary to maintain a good sharp point.

For air drying finishes the following rating table is used:

Up to the 5 notch	=	poor
Up to the 6 notch	=	fair
Up to the 8 notch	=	good
Up to the 10 notch	=	very good
10th notch and over	=	excellent

For baked finishes, the following rating table is used:

Up to the 9 notch	=	poor
Up to the 11 notch	=	fair
Up to the 13 notch	=	good
Up to the 16 notch	=	very good
16th notch and over	=	excellent

3. Flexibility and Adhesion Tests

This test is used to determine the flexibility and adhesion of the finish. The test panel is placed in the flexibility fixture finished side up and clamped in place. The handle of the fixture, equipped with a roller, is drawn down over the tabs of the test panel. The tabs are bent over radii of different dimensions.

The *flexibility* of the finish is indicated by its ability to withstand bending at the different radii.

The following table is used for air drying and baked finishes after bending the tabs of the test panel:

If the film is broken on all the radii including the 3/16 inch radius, the rating is poor.

If the film is broken on all the radii up to and including the 1/8 inch radius, the rating is fair.

If the film is broken on all the radii up to and including the 3/32 inch radius, the rating is good.

If the film is broken on the 1/32 inch and 1/16 inch radii only, the rating is very good.

If the film is not broken on all the radii, the rating is excellent.

If the finish is fractured (not broken) at any of the radii and the film can be easily removed by pressure with the thumb nail or

Fig. 5. Flexibility of a finish is tested by drawing down the handle of this fixture and bending the tabs of the test panel over different radii.

equivalent methods, the finish is considered to have poor adhesion and if the film can not be removed, the finish is considered to have good adhesion.

If the finish is not fractured at any of the radii, we make an "X" with the blade of a knife, razor blade, or equivalent, on the flat surface on the finished side of the panel.

If the film can be easily removed, by pressure with the thumb nail or equivalent, at the arrow point sections where the "X" lines cross, the finish is considered to have poor adhesion. If the film can not be removed, the finish is considered to have good adhesion.

4. *Coverage Tests and Seconds per Square Foot to Spray*

This test is used to determine the coverage per gallon of finishing material ready to spray. A 3 ft. x 3 ft. panel (9 sq. ft.) is used as a unit of measure.

The finishing material, reduced to the recommended standard viscosity, is poured into a graduate-type jar.

Air pressure is set as per standard for the particular type of finishing material. The 3 x 3 panel is placed in the spray booth and the material applied with the least number of strokes, shutting off the flow of material at the end of each stroke.

The intent of this test is to apply only enough finishing material to give a good commercial finishing job.

From these results we get an arbitrary, but comparable, indication of the square foot coverage to be expected per gallon of material.

We recognize that there is much to be questioned in the tests we make. In our work, the matter of thickness, in most cases, is subject to reasonably wide tolerances.

Color matching is visual and also within reasonably wide limits.

The test method we use suits our needs and, since we apply the same test to the materials of all suppliers, our results are comparable and, we feel, fair to our suppliers.

Testing Sample Procedure

In addition to the tests themselves, we also had the problem of obtaining test data without bringing in the matter of suppliers' identity.

For this reason, in our standard practice, the Standardizing Division makes all tests.

We receive the sample and first assign a code number. The code consists of

the month — (1 or 2 digits)
the day — (1 or 2 digits)
the year — (2 digits)

Assume that a requested sample reaches us on July 16, 1940. The vendor's name is recorded by us and all identifying marks are then removed from the sample and the code applied. At this point the code would read:

RCA #702 — 71640

Each succeeding sample would add a digit. For example, the second specimen of a specific type would read:

RCA #702 — 716401

If the material fails in our laboratory tests, a report is issued to the purchasing department and further relations with the vendor are in their hands. Failure on a test does not bar a vendor, although, obviously, we will not continue making tests indefinitely. As a matter of general practice, a failure usually results in a visit from the supplier and a discussion of the reasons for the failure.

If the test we make indicates approval. the balance of the quart sample, identified by RCA finish and code numbers, is sent to the factory for a production test.

If the factory results are good, we then order a 5-gallon lot and run the material through production to check our results. The production results finally govern. An approval on a laboratory basis is not sufficient. Unless the production test confirms the laboratory result, approval is not given. The material is then approved and an approval record is made. One copy is supplied to each purchasing department of our various manufacturing plants, and one copy remains in the files of the Standardizing Division.

This procedure continues until we have at least two approved sources of supply, and usually three to five.

When we first set up this test procedure, we found ourselves making an excessive number of tests. We now limit the number of samples on which we run tests to the scope of the job.

If consumption is very small, we stop testing when two suppliers are approved. If probable consumption is large, we establish at least three suppliers and usually more.

This method has been good both for us and for the suppliers. The number of samples decreased considerably and suppliers found they were not wasting their time and ours on samples which had no real business volume.

In our work on finishes, we found that most materials seemed to have a matching element known as "thinner".

As we reached the point where the identity of the manufacturer was no longer a major factor in the successful use of basic paint materials, we found that "thinner" was a real problem. At one time we had eight different kinds. We now have two.

One of the factors in our solution of this problem was the cooperation of the vendors.

Under our present system we give the supplier a sample of our "Standard Thinner" and ask "will your material work satisfactorily with this thinner?"

Our Standardizing Notices give processes which are always subject to revision as circumstances warrant. In the case of finishes, however, we also indicate the probable coverage to be expected per gallon of material. This is an arbitrary figure which remains constant and comparable because the measuring stick is always the same. Improvements in the technique and in establishing the records have now reached the point where the Standardizing Notice is a guide for ordering and stocking materials.

We do not feel that ours is necessarily the best system. In many respects our methods of test and approval are subject to scientific criticism, but the procedure has worked for us.

We have fewer finishes but better finishes.

We haven't fallen behind the progress in the art.

We have less obsolete material. Our inventory of finish materials is not a problem. We rarely have a "dead loss" and have only a small percentage to "use up" during the year.

We have a definite place of record to go to if we encounter troubles and usually locate the trouble quicker by going to the Standardizing Notice and reproducing the work on a controlled and known step-by-step process.

Our baking ovens are now set to one temperature because we request all "baked" type materials to be formulated to work with the temperature best controlled in our equipment. New "baked" type materials are considered with regard to our facilities.

In our company, our people all speak of Finish #—— and we rarely hear about "some more of that light blue with the peculiar wrinkle formation."

We avoid complex routines and strive for simplicity of procedure. The system described has worked well for us and it is on that basis that we feel free to commend it to the consideration of others who have similar problems.

Organic Coating

U. S. Pat. 2,264,373 M. T. Harvey, assignor to The Harvel Corp., Dec. 2, 1941. A coating composition adapted to be applied as a liquid film and to dry when so applied and comprising essentially a drying oil and an alkyl ether of a phenol derived from cashew nut shell liquid and which phenol ether has characteristic unsaturated hydrocarbon side chain of cashew nut shell liquid.

For a half century American industry has looked upon EGYPTIAN FINISHES as a yard stick with which other similar types of finishes were compared and measured.

Today they are more than ever a standard of comparison. Particularly in defense work. No manufacturer, engaged in this important work, can afford to take a chance with inferior or untried finishes. He hasn't the time, nor can he afford to experiment. EGYPTIAN FINISHES are being used in ever increasing quantities on all types of defense work requiring a finish.

To manufacturers engaged in defense work we extend a cordial invitation to discuss their finishing requirements with us. Our experience in this particular line may prove of value to them.

THE EGYPTIAN LACQUER MANUFACTURING CO.
ROCKEFELLER CENTER NEW YORK

EGYPTIAN FINISHES

EGYPTIAN Superior FINISHES

Finishing of Greyhound Coaches

Good Appearance of Greyhound Coaches a Matter of Constant Attention

W. A. DUVALL

General Manager of Maintenance, Greyhound Corporation, Chicago

THE management of the Greyhound Lines takes a just pride in those blue and white buses that skim along the highways, connecting from coast to coast and border to border the villages and hamlets, the farms and crossroad stations of the nation with scheduled and comfortable transportation. It is part of the company's service to provide good looking equipment in addition to having it in smooth-running order. Scratches, bruises, and other imperfections are not tolerated on the Greyhound coaches.

During the years of bus operation, and more particularly since the swing to aluminum and its alloys for bus construction, it has been found that because of the weave and strain around joints, applied mouldings, rivet heads, etc., the finish on bus units requires a strong tough film that stands up under punishment and does not have a tendency to rapid chalking; that retains its lustre over a long period of hard usage. After several years of laboratory research and field testing, a complete method for finishing these vehicles from the metal out has been developed, the final coating being of the synthetic lacquer type, giving a high lustre and a film that is practically impervious to the stresses of vibration and rapid temperature changes.

A bus is just pulling into the company's garage on Chicago's south side, let us say, having discharged its passengers at the downtown terminal following a long run. It is given, as is every bus after each trip, a thorough washing, and should there be any bad scratches the coach is sent to the painting department where it is touched up. The touch-up may consist merely of rubbing and polishing, or it may require the painting of one or more panels. Wheels also are given constant attention—marred wheels being promptly touched up with a special type of lacquer. In the Chicago garage, this type of lacquer is extensively used. The high natural gloss, the even coverage, and the uniform colors, added to the fact that it dries quickly, enables the Greyhound management to keep its coaches fresh-looking and rolling on scheduled time.

AN average of some ninety-five buses pass in and out each twenty-four hours at the Chicago garage. There is a large spray booth, big enough to swallow a whole bus unit at one gulp. The booth is equipped with automatic sprinklers and is lighted by a row of six flood lights along each side wall. A 36-in. fan, driven by a 7-hp. motor supplies ample ventilation, drawing the fumes out at the rear of the booth.

No coach is ever completely stripped unless absolutely necessary and, when necessary, the old paint is removed with a paint remover down to the metal surface. After this, the metal is hand-sanded with 120 emery cloth or 280 wet-or-dry paper until the metal is thoroughly roughened and bright. Thereupon it is washed with a commercial solvent cleaner to remove grease, oil, road-film, and dirt. Immediately after this treatment, a coat of reduced zinc chromate primer is sprayed on—thin enough so that the metal shows through. This is allowed to air-dry for about eight hours. Af-

Greyhound streamlined coach with fluted aluminum shingles on body and white enameled roof.

ter this a double coat is given of gray surfacer—two very light coats, one immediately upon the other, the second being a full wet coat. After a six-hour air drying, it is hand-sanded to remove all nibs, spray dust, etc. from the surface. Then, after all dust has been removed by means of an air hose and wiping, particularly around rivet heads, joints, etc. all spots that may have been cut through (by the sanding) to bare metal, are touched up with a spray application of reduced primer and allowed to dry for 30 minutes, whereupon the unit is ready for the finishing coats.

Three double coats of Greyhound Blue special lacquer are then applied, each first coat being a very light one, and each second coat a heavy wet one. Thirty to forty-five minutes are allowed after each double coat. The last double coat is somewhat heavier than the first two.

The blue field is then masked off and three coats of Greyhound white lacquer sprayed on the white field. When completed, this white field is also masked and the long curving gold stripe separating the blue and white fields is applied, together with an aluminum stripe on the front. All lettering is done by decalcomania transfer, and each letter is given a coat of varnish. All roofs are sprayed with white lacquer, except those of the Super Cruiser, on which white enamel is used.

FOR touch-up work where the old finish has been removed to the bare metal, or where an old panel has been replaced by a new one, a touch-up zinc chromate primer is applied in a very thin coat. Within 30 minutes this is recoated with a reduced surfacer and allowed to air-dry for about 8 hours, and then given the color coats.

For spotting in of small areas, the surfaces are sanded smooth and a coat of pyroxylin type combination of primer-surfacer applied around the entire area, going out to a feather edge.

On the Super Cruiser, the long polished fluted aluminum shingles are applied with screws concealed beneath strip moulding, and are wax-coated. These aluminum surfaces are rewaxed at the completion of each 15,000 mile period, and any shingles marred or bent during a run are immediately replaced. At the end of each 15,000 mile running period the ceiling and other exposed painted surfaces on the interior of each coach are washed and waxed. Seats are removed and refinished after each major overhaul.

Garages, where booths and other spray painting equipment is installed, are also maintained at Cleveland, Pittsburgh, San Francisco, Minneapolis, Kansas City, Memphis, New Orleans, and many other points, together with some hundred smaller garages throughout the country, where touch-up work may be done on buses marred in transit.

Organic Coating

U. S. Pat. 2,262,092 M. R. Buffington, Nov. 11, 1941. A fire resistant, vulcanizable paint material resistant to water, oils and chemicals and having a high degree of flexibility, adhesion and toughness comprising polymerized chloroprene, chlorinated rubber, a resin, a vulcanizing agent and an organic solvent therefor.

Mica In Aluminum "Paints"

Question. I have learned that it is possible to add a portion of flake mica to aluminum powder so that a smaller amount of aluminum can be used per gallon of vehicle. Is this a good practice? It has occurred to me that this would be one means of conserving aluminum powder.

Answer. It is true that mica may be added to aluminum powder and by so doing reduce the amount of actual aluminum powder required. Within limits such additions of mica have little or no effect on the appearance of the film of finishing material. However, tests have indicated that with regard to general durability and resistance, aluminum finishing materials containing mica are not as good as those made with straight aluminum powder. If decoration and not protection is the primary requirement, then certainly the use of mica with aluminum powder is one means of conserving the latter.

It might be mentioned that many federal, state and municipal specifications require that no mica be present in aluminum paste and powder and that it is necessary today to label all aluminum powder and paste containing mica, to indicate that materials other than aluminum are present.

WALKER'S
Finishes to Fit the Product

Zinc Chromate Production Primers, Fillers, Surfacers & Undercoats, Short High Bake Enamels, Chlorinated Rubber Enamels, Rapid Drying Synthetic Enamels, Lacquers and Enamels for All Surfaces, Wrinkle Enamels and Novelty Finishes.

H.V. WALKER CO.
MAKERS OF FINE FINISHES
ELIZABETH, N.J.

The Buy-Word Is "Enthone" for ENAMEL STRIPPERS

For the past 4 years Enthone strippers have been used by hundreds of manufacturers for quickly removing organic finishes from civilian goods.

And NOW—fast working, patented* Enthone strippers are helping to speed the flow of war goods.

Here's what Enthone strippers do:
★ Strip synthetics, japans, lacquers rapidly.
★ Leave all metals clean and bright.

SPECIAL STRIPPERS for SPECIAL PROBLEMS — TELL US YOUR PROBLEM!

THE Enthone CO.
*Protected by U.S Patent No 2242106 NEW HAVEN, CONN.

Finishing Steel Containers

By J. W. GIFFORD

Plant Manager,
Bennett Mfg. Co.,
Chicago, Ill.

SINCE the steel container—in the form of a pail, drum, or barrel—has been recognized as a standard packaging unit for the shipment of liquids, solids, semi-solids, powdered and crystalline products—it is important from the sales and publicity angle that they present an attractive and pleasing appearance, as thus it can be made to carry a sales message for the products it contains while in transit and moving through the channels of distribution.

The Bennett Manufacturing Company, in Chicago, makers of sturdy steel containers, has recognized the importance of an attractive, enduring finish that will stand up and take the harsh treatment and rough handling sometimes meted out to shipments in the course of transportation and distribution. In the attempt to carry out this conviction, one of the problems confronting the management was to find equipment that would enable them to furnish pails and drums at a high rate of speed at moderate cost,—the outside and bottoms of pails and the top of the lids to be finished with pigmented lacquer, while the inside of the pails and the underside of the lid to be finished with a clear lacquer. Specially engineered equipment was therefore installed, solving completely the problem that had faced them.

Barrels, or drums as they are frequently called, varying in size from 15 to 65-gal. capacity and fabricated from 24 to 16 gage sheet steel, come from the production line, down a gravity chute to enter an oil-fired preheating oven. After passing along the 60-ft. stretch of this oven, having an average temperature of 300° F., the drums arrive clean, dry, and warm at the drum spray booth, where they are placed on a roller which revolves them at 250 r.p.m., while two operators handling the paint spraying, coat the drum, each doing one end and half of the shell. The pulling of a lever ejects the painted drum onto a conveyor which carries the drum upward to discharge it onto the baking oven conveyor. This oven is 80 ft. long, in which the drums make two complete passes during the journey of 160 feet, at an average temperature of 230° F. At the end of this oven the finished drums roll gently onto an upender, which in turn sets them on end and passes them onto a gravity roller conveyor, down which they glide either to storage, freight car, or truck loading platform.

In cases where lettering or special designs are specified, this is done by means of a silk screen process in any color or decorative pattern, adding not only advertising value but also more durability to exterior finish because of the increased thickness of the paint film. This is applied automatically on a compressed air-driven machine, insuring a uniform film thickness and evenness of design. Lettering and decorative designs are also sometimes applied by means of decalcomania transfers. If lithographing is desired, it is done outside the Bennett plant by commercial lithographers.

Finishing Pails

THE pails made at this plant range from 2½ to 7 gal. capacity, and are made from 28 to 22 gage sheet. As they come from the production line they are tested for leakage with compressed air while submerged in a water

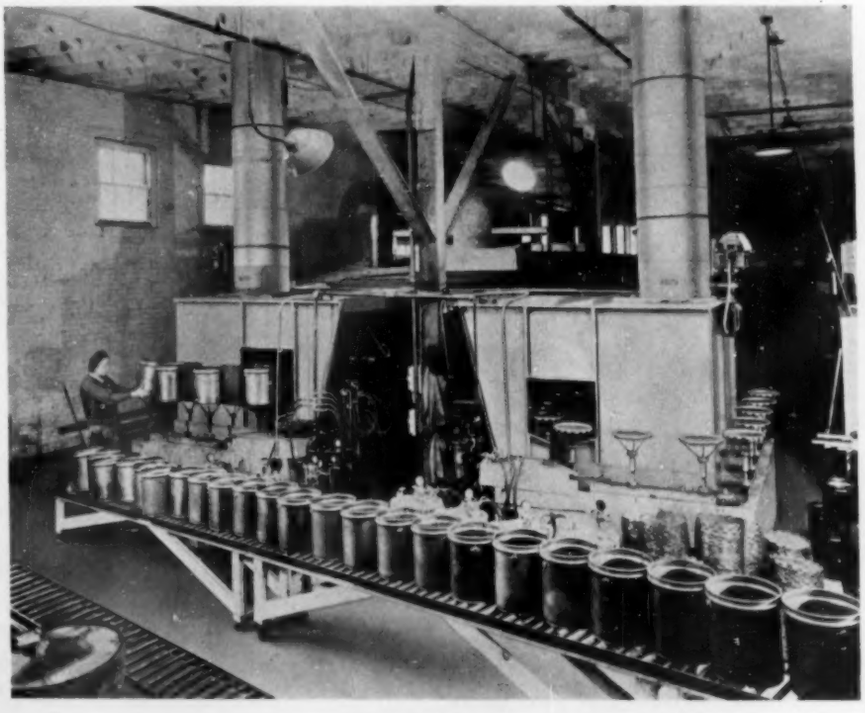


Fig. 1. Feeding end of the automatic spray booths—one side handling the steel pails, while the other side handles covers.

bath. The wet pails are then placed on a slat conveyor and carried twice through an 80-ft. camel-back oil-fired oven, heated to an average temperature of 300° F. As the pails come from this preheating oven, they are free from any traces of grease, thoroughly dry, and sufficiently heated to present a suitable surface for the paint spray. Thereupon they are placed on paint machine spindles which pass into an automatic paint spray booth where, as each open pail whirls around on its spindle, four automatic spray guns (arranged at different angles) completely cover the outside body and bottom of the pail with a uniform coating. As this operation is going on, an extension arm spray gun descends into the open pail, coating the inside surface with a rust inhibiting varnish. This gun may also be used, if desired, for applying any of the new synthetic lacquers commonly being used for coating the inside of containers carrying the products of the food and chemical industries.

Pail covers, after passing through the preheating oven (where a composition gasket has been baked into the groove) are placed on a cover spindle and are carried through another automatic spray booth where they whirl and pass beneath three guns automatically directing sprays of the same pigmented material used in the other booth for spraying the outside of the pails, while a fourth gun, spotted beneath the cover, directs a spray, which spreads over the entire underside of the cover a uniform film of the same material used for coating the interior surface of the pails.

Pressure tanks of 10-gal. capacity are used at all the spray booths. These are cleaned and filled at a central paint mixing and storage room,—a fireproof enclosure equipped with an automatic fire door. The pressure tanks are arranged in tandem, so that as one becomes empty another can be switched on at once without any stoppage in production. Baking enamels are used entirely as outside coatings for both drums and pails; a varnish or synthetic lacquer being used on the inside surfaces of the pails.

As the painted pails and covers come from their respective spray booths, they are placed on separate conveyors—the covers being hung on an overhead hook conveyor, while the pails are placed on a flat bar conveyor —both, however, passing through the baking oven together so that on reaching the exit end of the oven, the corresponding parts may quickly be assembled, and, with the wire bail, or handle, in place, the completed pail is hung on another overhead conveyor which winds through the storage area, passing the truck loading dock, and on to the freight car loading doors. Both the drum line and the pail line pass the truck and car loading points at the same point, permitting mixed loads to be made by either motor truck or rail car on the siding served by the Illinois Central.

The baking oven through which the pails and covers pass on their separate conveyors is an 80-ft. oil-fired unit divided into three sections, each individually controlled, the heating ducts being so arranged that either the same heat may be maintained in all the sections or different temperatures in each, as desired;—all controlled by the setting of a regulating dial. Ovens are all fired by two oil burners automatically controlled, and are equipped with all the necessary safety devices.

Mr. Steve Bennett, a pioneer in the manufacture of steel containers and formerly President of Wilson & Bennett Mfg. Co., in 1939 organized the Bennett Manufacturing Company, of which he has been president since its organization. The business has steadily grown until the company now occupies a modern sprinklered plant covering 65,000 square feet of floor space in three separate yet connected buildings. The finishing equipment consists of three specially engineered units, as described above, capable of finishing from 600 to 1,000 pails and 250 drums per hour. The Bennett Manufacturing Company also has a large drum plant in New Orleans.

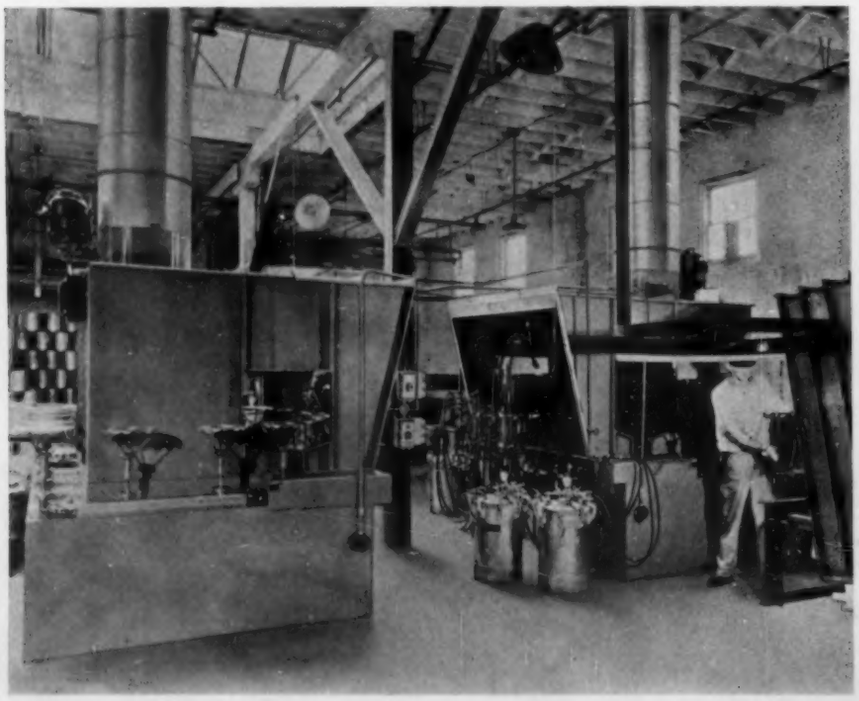
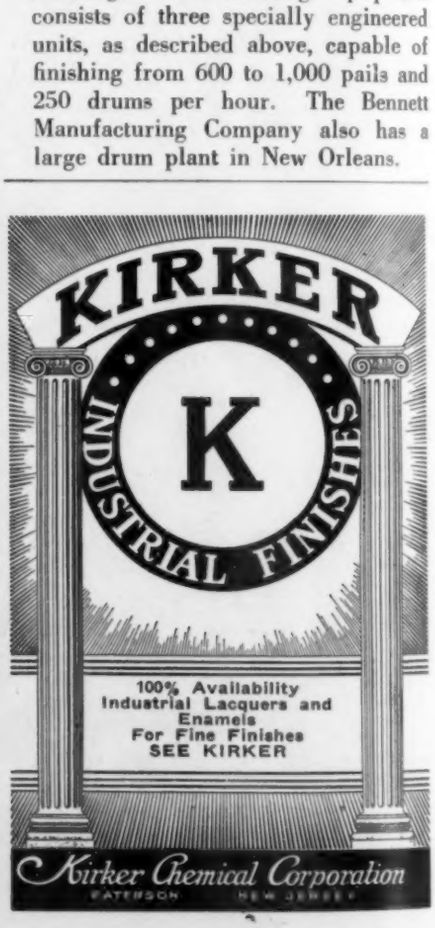


Fig. 2. Discharge end of the automatic spray booths, showing pails being removed at right and transferred to flat bar conveyor which carries them to the oil-fired oven.



NEW EQUIPMENT AND SUPPLIES

LATEST COMMERCIAL DEVELOPMENTS IN ORGANIC FINISHING

New Degreasing Solvent

Warner Chemical Co., Division of Westvaco Chlorine Products Corp., Chrysler Bldg., New York, N. Y., have announced the development of a new blend of trichloroethylene, called "Tromex", with stabilizing agents to produce a new degreasing solvent.

This solvent is recommended for use in the standard solvent and/or vapor degreasers. The manufacturer states that the material is so stabilized that it resists acid formation and delays the formation of acid decomposition due to hydrolysis of the chlorinated solvent. The boiling point of the solvent is 187° F., and thorough cleaning of metals is claimed, using one chamber, dual chamber or a full automatic degreasing machine.

The solvent is stated to be available through local distributors, the names of which can be secured by writing the Warner Chemical Co. Literature describing the new solvent is available upon request.

Rust Proofing and Cleaning Solution

A new rust-proofing and metal cleaning solution called "Ruscat", has just been developed by the Research Laboratories of the United States Stoneware Co. of Akron, Ohio. Its principal use is for the cleaning and preparation of metal surfaces before the application of corrosion resistant paints and coatings and also for the purpose of preventing further rust formation.

The use of the material produces a mild etch over metal surfaces, resulting in the development of a chemically adherent inorganic base over which the lacquers and coatings are made to gain their maximum adhesion. A thorough chemical cleaning of the minute pores of the metal is achieved along with the removal of all surface contamination, scale and rust.

The cleaning solution may be applied by brushing or dipping. After a few minutes, the solution may then be wiped off and allowed to dry.

Another use for "Ruscat" is to facilitate the handling of iron or steel after long exposure, storage and handling—prior to being used for fabrication, etc.

Zinc Coating of Aluminum and its Alloys

Colonial Alloys Co., E. Somerset, Trenton Ave. & Martha St., Philadelphia, Pa., have developed a process called "Bondizing", which is a chemical method for producing a protective coat on aluminum and aluminum alloys.

The coating, according to the supplier, consists of firmly bonded zinc, which is electrochemically protective to aluminum. For applying the finish, the work is degreased and pickled, and then immersed into the Bondizing solution for from ½ to 5 minutes depending upon the alloy being treated.

The coating is claimed to be an excellent base for soldering or tinning and to be receptive to zinc chromate or paints, enamels and lacquers. The operating of the process is said to be relatively simple and can be accomplished with only a limited amount of equipment.

Black-Out Paint

Hilo Varnish Corp., 42 Stewart Ave., Brooklyn, N. Y., have recently announced a black-out paint that is stated to conform to the specifications of the Camouflage Committee of the National Paint & Varnish Association for Type 1.

The product is waterproof and may be used for inside or outside purposes. It is stated to black out fluorescent and other lights and to flow out to a smooth, even, dull finish, giving complete black-out in one coat. It is claimed to resist heat up to 212° F., and to hide approximately 500 sq. ft. per gallon, more or less, according to the smoothness of the glass. It dries to touch in 15 minutes and is hard in two hours, and can be removed with kerosene or other mineral solvents.

In the application of the paint, the glass is cleaned and dried, and the paint applied in a full, even coat by brushing or spraying, using the material undiluted. Both inside and outside surfaces of the glass should be painted.

New Rust Inhibitor for Black Iron

The Watson-Standard Co., Pittsburgh, Pa., announces the development of a new organic coating for black iron which they claim can be applied very economically at the steel mill, and will result in the solution of many of the coating man's problems.

This is used as a protective coating in lieu of the oil previously used on the metal.

This new product is of the oxidizing type, and it is said to provide exceptionally fine protection against corrosion, serving as a prime coat for all types of synthetic and oleo-resinous coatings.

"No-Odor" Paint

A newly improved paint, designed for use in plants and offices where odors from conventional paints are offensive to workers, has been announced by American-Marietta Co., 43 E. Ohio St., Chicago. Not perfumed but actually de-odorized before being canned, it is claimed to make possible painting in winter or summer without discomfort. Windows may be kept closed while the paint is being applied. The produce sets in three hours, and is completely dry in 12 to 15 hours.

Designated "Valdura No-Odor" paint, it may be used on plaster, wall board, wood, cement, brick or metal, and is available in flat, egg-shell and gloss finishes. Coverage is 700 square feet to the gallon, with hiding power that makes possible one-coat jobs in many applications. It may be applied with a spray gun when cut with one pint of the proper thinner to one gallon of paint. Flat and egg-shell finishes may be stippled.

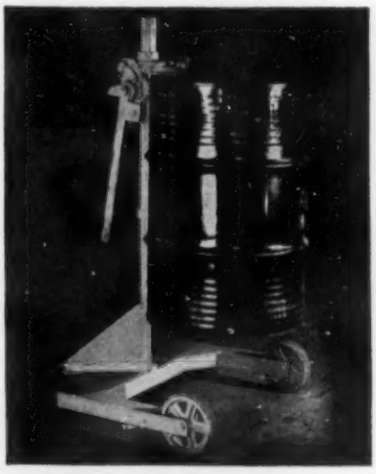
All finishes are washable, and colors are designed not to fade or dull with repeated washings. High reflectivity reduces light requirements. Colors available are white, cream, ivory, buff, grey, blue and green.

Drum Handling Equipment

Ernst Magic Carrier Sales Co., 1456 Jefferson Ave., Buffalo, N. Y., have announced a new 14" Lift Model carrier for placing and removing 55-gallon drums on and off skids, scales and platforms.

The 14" refers to the fact that containers can be raised a full 14" off the floor by lowering the handle from the straight to horizontal position.

The equipment enables the handling of drums by one man and it is claimed to minimize danger from accidents during lifting. In addition, saving of floors and lengthening life of drums are also claimed.



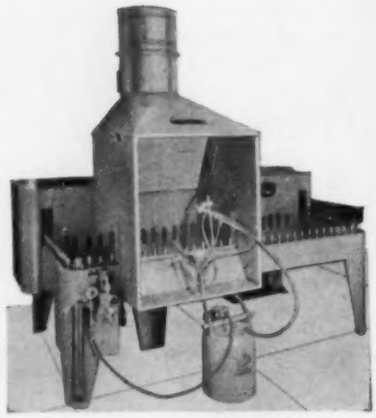
Drum handling equipment.

Automatic Unit for Airpainting Shells

Speeding the flow of ordnance to our armed forces is this new type "Paasche Automatic Unit" for painting the exteriors of 20 millimeter shells. Average production is 1800 pieces per hour—painted and dried, according to the manufacturers. Larger units for greater production are also being manufactured and units similar to that pictured are made for painting 37 and 40 millimeter shells of various types.

In the operation of this machine, the 20 millimeter shells are loaded manually and conveyed to the spraying station on removable holding and shielding fixtures. Special off and on control operates the automatic airbrushes as shells come in position. While being sprayed, shells are revolved rapidly to insure perfect and complete coverage.

After shells receive the coating of lacquer, they are conveyed through an electrically heated, thermostatically controlled oven for a three minute drying period.



Automatic unit for airpainting shells.

The unit includes a spray booth with exhaust, electrically heated drying oven, "Clamptight Cover" material pressure tank, water, oil and dirt separator to provide clean dry air and automatic airbrushes with off and on control.

Paasche manufactures a complete line of Automatic and Semi-Automatic Units for airpainting interiors and exteriors of shells, bombs and mines, fuse parts and miscellaneous items.

Bulletin F12-41 describing these units is available from Paasche Airbrush Co., 1909 Diversey Parkway, Chicago, Ill.

Specification Paints Explained

Many manufacturers have been hampered in figuring on Government contracts involving specification finishes, which are usually identified only by code numbers, because of lacking material costs, thinning and drying data, and other essential information. In answer to this need the *Roxalin Flexible Lacquer Co.*, Elizabeth, N. J. announces publication of a convenient file folder entitled "Facts on U. S. Government Finishes". This folder contains data sheets on the widely used Army and Navy specification finishes and tells how and where they are applied.

With this information before him it is now possible for a manufacturer not heretofore familiar with Army and Navy finishes, to figure his unit costs accurately and establish the most efficient production schedule in keeping with his particular equipment.

The file folder and an up-to-date set of "Facts on U. S. Government Finishes" may be obtained by writing to Roxalin Flexible Lacquer Company, Elizabeth, N. J. Box 511.

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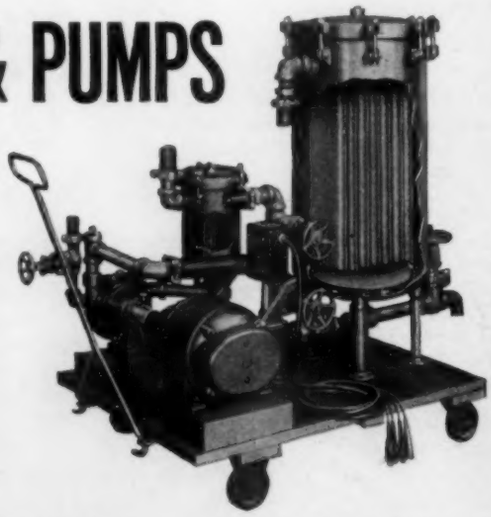

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CORROSION TEST EQUIPMENT

Designed to determine the corrosion resisting qualities of plated or coated metal, alloys, metal parts, organic finishes, etc. This equipment combines necessary features so that Salt Spray tests can be conducted to specifications at Controlled Temperatures to 130 Deg. Fah.

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INDUSTRIAL FILTER & PUMP MFG. CO.
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Manufacturers' Literature

Hand Tools

Skilsaw, Inc., 5033 Elston Ave., Chicago, Ill., have just issued their catalog No. 43, entitled, "Tools for Defense of America", in which the company's hand tools are described and illustrated. These tools include portable saws, drills, grinders, sanders, as well as bench grinders, blowers and floor finishing equipment.

Munitions Painting Equipment

Paasche Airbrush Co., 1909 Diversey Parkway, Chicago, Ill., have just issued a booklet containing bulletins describing various equipment for automatic finishing of munitions. Various types of equipment are described for finishing of shells, mines, bombs, fuse parts and miscellaneous items.

New Bracket for Mixer

The Eclipse Air Brush Co., 400 Park Ave., Newark, N. J., has announced the addition of two V-shaped brackets to hold its direct drive air motored agitators. These brackets are made in two sizes: to fit thirty- and fifty-gallon drums.

There is a screw clamp at the side of the bracket to allow for variations in the sizes of the drums, and to insure steadiness of the Pneumix agitator. The mixer can be adjusted to any angle.

The use of the Pneumix with the new holder does not in any way change the spark-free operation of the mixer which retains all its properties of variable speeds, light weight, quiet, splash-free performance.

Oil Fired Heaters

Despatch Oven Co., Minneapolis, Minn., have just published their 4-page illustrated Bulletin No. 73 describing the company's oil fired heaters. These heaters burn all grades of oil, and are stated to maintain high combustion efficiency for industrial heating operations, for ovens, dryers and furnaces.

Thirteen features are outlined, numerous photographs illustrate uses for the heaters, and specifications for the heaters are also given.

Painting Equipment

Catalog #80, a 32-page, 8½ x 11 booklet, has just been issued by the *Eclipse Air Brush Company*, 400 Park Avenue, Newark, N. J. It covers their complete line of spray equipment for both manual and automatic operation, in addition to their Pneumix air motored agitators for all mixing jobs in batches up to 200 gallons.

The introductory section of the catalog outlines the reasons for the low pressure principle under which all Eclipse spray equipment operates.

This free-on-request booklet is illustrated with many pictures of the equipment in operation on various types of work.

Paint Selection Charts

A new handy means of selecting the best paint without detailed technical study of properties of all finishes that might be suitable for a given application is provided in the Valdura Paint Selector, issued by *American-Marietta Company*, 43 East Ohio Street, Chicago.

The Selector makes conveniently available to architects, contractors, purchasing officials, dealers, and plant and building maintenance engineers all information on properties of, and all application data necessary to choose properly from 43 paint, enamel and varnish products. It folds to letterhead size, making it convenient to keep on a desk top for daily reference, or to file for future use.

Two charts are embodied in the Selector. Fifty-one divisions on the first chart list all types of surfaces that might be encountered in industrial, commercial and residential painting, and under which are listed one or more paints suitable for the application. A second chart gives all properties of each paint to facilitate selection of the finish most suitable when a choice is offered by the first chart. Information included is whether the finish may be used under water or over graphite paint; maximum heat resistance in degrees F.; relative resistance to alkalies, acids, moisture, abrasion, sun and oil; coverage, and drying time. The chart also lists the most suitable thinner and primer for each type of paint.

Other information valuable to the paint specifier or user includes a table of geometric equations, one showing light reflection values of standard colors, and tables to aid in estimating paint requirements for exteriors and interiors.

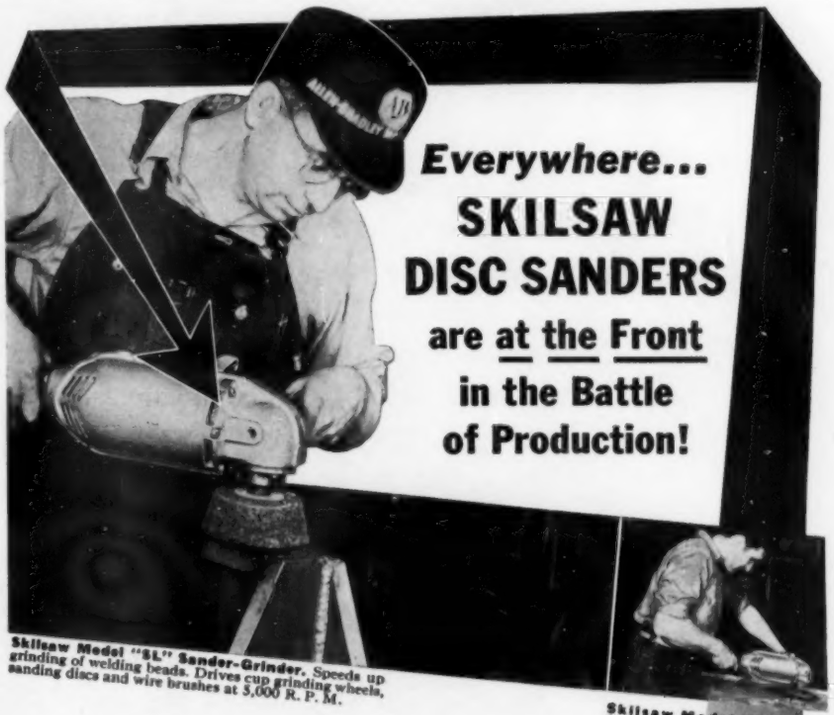
Despatch Oven Co., Minneapolis, Minn., have announced the appointment of *H. W. Munday*, 332 S. Michigan Ave., Chicago, Ill., as their district engineer in the Chicago territory on industrial ovens and air heaters for finish baking, drying, coil and armature baking and similar processes involving equipment of this type.

Mr. Munday has had many years of experience in the industrial oven field.

Despatch Oven Co., announces the removal of its purchasing, engineering, sales and executive offices to 722 Central Ave., Minneapolis, Minn. This move provides for additional manufacturing and assembly facilities at the factory, which will remain at 622 Ninth St., S.E. It will also result in increased output and better customer service.

Organic Coating

U. S. Pat. 2,268,415 A. J. Morway and F. L. Miller, assignors to Standard Oil Development Co., Dec. 30, 1941. A paint composition comprising a chlorinated isobutylene polymer, a drying oil and a pigment.



Skilsaw Model "SL" Sander-Grinder. Speeds up grinding of welding beads. Drives cup grinding wheels, sanding discs and wire brushes at 5,000 R. P. M.

Wherever the fight for production is fiercest—wherever war materials are being built fastest you'll find SKILSAW DISC SANDERS at work...speeding up every surfacing job...making each man, each minute more productive . . . saving days and dollars for quicker Victory!

SKILSAW DISC SANDERS are lighter, easier to handle and far more powerful. That's why they're so widely preferred in aircraft, tank and other war production plants . . . to speed up all sanding, grinding, filing, buffing and polishing. That's why they belong in your plant, too . . . for faster, better work on countless jobs with wire brushes, sanding discs, grinding wheels and polishing pads. Ask for a demonstration of SKILSAW DISC SANDERS. 6 POWERFUL MODELS.

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Skilsaw Model "G" Disc Sander. Removes spot welds ...smooths down welding beads ... blends metals to a smooth finish. Ideal for removing rust and dirt.

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Skilsaw Model "SL" Sander-Grinder. Grinds down fins on steel castings with 6 in. cup grinding wheel. Speeds up all metal cleaning, filing, surfacing.

JUNE

8 · 9 · 10

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30th NATIONAL CONVENTION

The 30th Annual Convention will be held three days instead of the usual four, to save your valuable time. Three days of truly worthwhile events are in store for you when you come to Grand Rapids. Papers dealing with all phases of metal finishing, with particular emphasis on plating applications in the defense effort will make up the educational program. Four educational sessions with the same number of high quality papers as have been given in the past will be of interest to you.

There will be plenty of recreational highlights too. The Good Fellowship Party, Aunt Ella's Party and the Dinner Dance will keep you in good spirits and entertained thruout the three days.

Metal finishing is vital in our war effort and research in all phases of metal finishing will help to win the war. Keep posted on the new developments and methods by attending the Grand Rapids Convention where you will hear nationally known researchers in the metal finishing field.

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1868-1935

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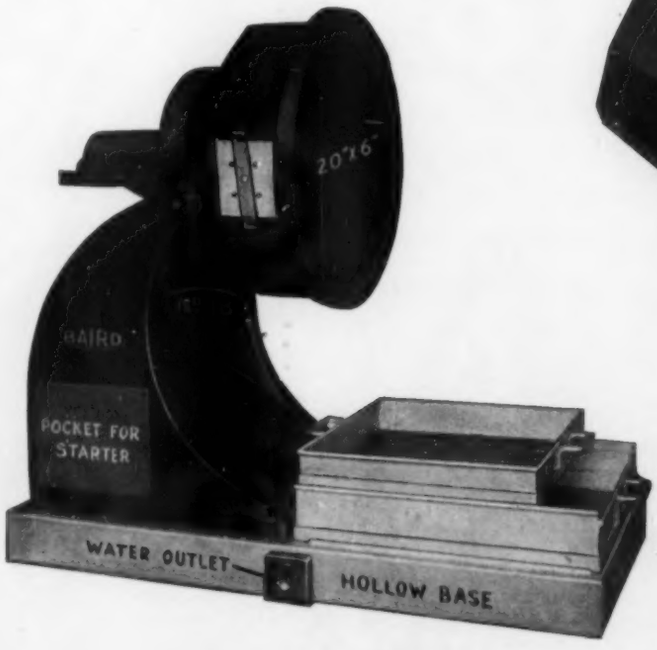
METAL FINISHING (formerly Metal Industry) has been the leading publication since 1903 in the field of metal preparation, electroplating and coating.

HORIZONTAL BARRELS **TILTING BALL BURNISHING BARRELS**



This shows a High and Narrow Type of Barrel mounted on "Baird" Model B. or Pedestal Type Motor driven Oblique Tilting Tumbler.

As shown the barrel was lined for use for burnishing with hardened steel balls.

These barrels may be of any suitable material depending on the job. Cast iron or fabricated steel unlined or lined with rubber etc. for rolling in abrasives.

Made in 20" dia. x 6" for No. 1 Tumbler
Made in 24" dia. x 8" for No. 2 Tumbler

This shows the side of a No. 1 BAIRD Model B. Single Oblique Tilting Tumbler with a No. 22 Sheet Steel Polygonal Barrel and with an Automatic Electrical Tilting Device.

This device AFFORDS GREATEST SAFETY—LEAST LABOR—LEAST FLOOR SPACE—LEAST AMOUNT OF DISTANCE TO MOVE WORK in USING the tumbling barrels. SAVES TIME AND FLOOR SPACE.

When tumbling questions come up "ASK BAIRD ABOUT IT"

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BRIDGEPORT, CONNECTICUT

Since 1846 specializing in high production machinery for articles of wire and for ribbon metal. Also machines to turn, bore, etc., castings, forgings, etc., up to 10½" diameter.

VOL. 40, NO. 4 METAL FINISHING APRIL, 1942
PREPARATION, ELECTROPLATING, COATING

Plating After April 1st

APRIL 1st of this year was a serious day for the plating industry because many orders restricting the use of metals for plating went into effect at that time. In addition, limitation orders on the use of base metals, such as tin, copper and lead, and limitation orders on many manufactured goods using plating, have drastically reduced the volume of plating. No significant changes have been made on the restricting orders discussed in the Editorial of the March issue of METAL FINISHING, and they will not be discussed here again. However, restrictions have been placed on molybdenum (Order M-110, March 18, 1942), rhodium (M-95, March 12, 1942) and new restrictions have been placed on chromium and its salts (Order M-18-b, March 26, 1942) and on the use of tin (Order M-43-a, March 17, 1942) and these are discussed elsewhere in this issue.

In spite of the many curtailments, there is a considerable volume of plating and finishing being done and war plating will, no doubt, increase. However, there will not be a sufficient volume of work to keep the plating industry operating near capacity. The type of plating for war purposes will be different from that in peace-time. Decorative nickel and chromium plating have practically stopped, but there has been an increase in cadmium, zinc and silver plating. Obviously, the thing to be done by plating shops is to attempt to secure war plating by contacting local plants engaged in war production and pointing out the facilities of the company to do various finishing jobs. Most equipment in plating plants can be used for other war finishing operations, such as aluminum anodizing, magnesium treatments, chemical blackening, heavy chromium plating and organic finishing by making only small changes in or additions to the equipment. Even though there are some metals still available for plating, such as silver, gold and a small amount of zinc, the increased demands for the production of war goods will result in more and more limitations being placed upon production of non-essential goods, and thus the attempt to change over to non-banned processes for production of civilian goods may be of only a temporary nature.

There appears to be no likelihood of lessening of restrictions on plating or the use of metals and thus just drifting along hoping that the picture will change, will probably end in disaster. In many cases, plating plants are being installed, and have been installed in new plants making war goods where plating shops were near at hand to do the work. It is up to the plating plant proprietors, therefore, to make certain that all accessible war goods manufacturing plants are acquainted with the facilities for finishing of metals. This is important to both conserve metals and other materials that would be required in making new equipment and to enable the present finishing establishment to remain in business.

Defense Highlights

In view of the fact that many people in the finishing industry are not fully familiar with the conservation and limitation orders issued by WPB, we are herewith giving a short synopsis of the most important orders referring to the finishing industry. Full details can be found in the various orders mentioned, and these can be secured from WPB in Washington, or frequently, from local WPB offices.

ALUMINUM—This metal is controlled under the various M-1 Orders and on February 17, 1942, Supplementary Order M-1-f placed aluminum under complete allocation control. This order controls the shipping, selling, purchasing and using of all aluminum alloys, in which the principal ingredient by weight or volume is metallic aluminum. Order M-1-g issued March 10, 1942, placed aluminum pigment and aluminum paint under a complete allocation system. This order requires that specific authorization must be obtained for the manufacture, use or sale of aluminum pigment and aluminum paint, except in retail distribution to the ultimate consumer.

CADMIUM—The distribution and supply of cadmium was originally controlled under General Preference Order M-65 issued January 17, 1942. This order placed cadmium and all cadmium containing compounds, salts, residues and alloys, under the priority system, and provided that a preference rating of A-10 or higher was necessary for delivery. On January 27, 1942, Order M-65-a was issued providing for drastic curtailment in the use of cadmium plate. Since February 1st of this year, no cadmium should have been used in the production of any item in a long list of items included in the order. This list covers almost all of the products formerly cadmium plated, and one statement bans all plating for primarily decorative purposes. Certain exceptions are provided. For example, electrical fittings and contacts, plating for certain textile machinery, and the use of cadmium plate for control and measuring instruments are allowed, providing that any less scarce material is impractical. Work produced for certain Government agencies and for certain safety regulations is excepted, as well as that bearing a preference rating higher than A-2.

COBALT—Due to the uncertainty of shipments of cobalt from abroad and the great demand for this metal in various alloys, cobalt was placed under priority control on November 4, 1941, with the issuance of general preference Order M-39. This order does not ban the use of cobalt for plating purposes, but places the requirements of metal and salts for plating and for other uses under the priorities system.

CHROMIUM—This metal is distributed under general preference Orders M-18-a and M-18-b. The use of chromium plate has not been restricted, but the acquisition of chromium salts is, of course, under the general preference order restrictions. On March 26, 1942, Order M-18-b limited the use of chromium in various chemicals for different processes. This order restricts the manufacture of chromic acid to 80% of a previous base period, as well as limiting the use of chromium compounds in the manufacture of ceramics, soap, glass and for other processes.

COPPER—The most important order as far as the plating industry is concerned is M-9-c amended December 10, 1941. This order curtails or drastically restricts the use of copper in the manufacture of almost all items for which it was formerly used. Certain items are given in a list of exceptions, such as plating for fire-fighting equipment and devices for safety control. Certain exceptions to the limited cases are made that allow the use of copper plating to some extent. If the plating is not primarily for decorative purposes, then copper plating may be continued to be used. When the use of, or the normal wear of the items on the banned list make impractical any other form of coating, copper plating may be used, and lastly, if the object being plated was made of copper or copper base alloy preceding the issuance of the order, then 5% of this weight of copper can be used for plating. If the ultimate aim of the plated coating is decorative, such as when copper or brass plated undercoats are used for gold finishes, then copper plating is not allowed. General exceptions are made for objects plated for Government agencies, for safety equipment, chemical plants, research laboratories, for certain mechanical and electrical equipment and for food processing equipment. Order M-9-c-1 relates specifically to restrictions on the use of copper in the manufacture of shoe findings.

LEAD—Lead was originally placed under priority distribution on October 4, 1941, when general preference Order M-38 was issued. However, a more important order as far as the finishing industry is concerned is M-38-c issued January 10, 1942. This order has prohibited, since April 1st, the use of lead in many articles in which it was formerly used. These include casket hardware, badges, emblems, art goods, toys and many other articles. The order does not specifically refer to lead plating, but obviously if lead is restricted in the manufacture of various items, it does not matter whether the lead is cast or electroplated. Exceptions are made to the use of lead as anodes and cathodes in electroplating processes, baths for heat treatment of steel, for fire fighting and protective equipment, and for solder, as well as for some other uses. This order has been a serious blow to the finishing industry because it has restricted the use of one of the important base metals.

(*Concluded on page facing inside back cover*)

Silver Plating[1]

BY N. E. PROMISEL[2] AND D. WOOD[3]

Electroplating silver on other metals is over a hundred years old. One of the first baths proposed was the cyanide bath which, with slight modifications, is the standard silver bath today. Both the potassium silver cyanide and the sodium silver cyanide bath are in commercial use today. Aside from the higher cost of the potassium salts, the potassium bath is the preferred one. The brightening agent used in most plants is carbon disulfide, proposed many years ago. A relatively new silver cyanide bath, which is gaining in popularity, is that containing from 11 to 15% of potassium nitrate. As pointed out by the authors, this has many advantages over the older cyanide baths. Full operating details, based on best modern silver plating practice, are detailed and discussed.

Introduction

THE field of silver deposition with which this present paper is particularly concerned is the so-called silver plating field. Silver coatings are applied to a large variety of baser metals and alloys, notably to copper-nickel-zinc alloys. Among the large variety of metal articles that are silver plated are eating utensils and decorative metal articles of the home. Other silver plated articles include musical instruments, surgical instruments, chemical engineering equipment and electric circuit parts. Finally, it should be mentioned that the electrodeposition of silver in the silver coulometer forms the very basis of the international ampere.

The origin of silver electrodeposition is closely related to the birth of the electroplating industry itself, which occurred in the latter part of the first half of the nineteenth century. The earliest patent granted for the application of the principles of electrodeposition for decorative purposes is credited to Elkington and Barratt, of England, in 1838. Two years later, Elkington received a patent for silver plating, and it is symbolic of the value of original electroplating formulas and the "staidness" of the plating industry that this early patent described essentially our most popular modern silver plating bath, that is, the double cyanide bath with excess cyanide.

In the hundred years that have elapsed since Elkington, numerous investigations and publications have dealt with variations of his formula, together with many novel ones. The literature up to 1913 has been well reviewed by Frary[4] and the solutions used up to that date may conveniently be divided, for the most part, into the following classification:

1. *Simple silver salts* in acid or ammoniacal solution, with and without addition agents. Silver nitrate in a nitric acid solution, often with glue, was a common type. Other silver salts used and advocated were fluosilicate, perchlorate, methyl sulfate, bisulfite, lactate, citrate and tartrate. With the exception of the nitrate solution, which is still used industrially in the electrolytic parting of silver from gold as well as in the standard silver coulometer, none of the other silver salts ever attained any degree of commercial application.

2. *Cyanide solutions*, compounded from the silver nitrate, chloride, oxide or other silver salt, excluding the cyanide. Silver chloride in particular was popular, probably because it was so readily prepared, in a relatively pure state, from scrap silver or waste silver solutions. Ferrocyanides were also frequently used as a partial substitute for cyanide itself. Brighteners, notably carbon disulfide (which is still used), were employed to improve the otherwise dull, milky appearance of the silver deposit.

3. *Cyanide solutions of silver cyanide.* This is the type of silver plating bath originally described by Elsner in 1842. Sixty years later it was definitely acknowledged to be superior to all other silver baths, and today it comprises the largest volume of solution used for silver electroplating. It is this bath which forms the subject matter of the major part of this present paper.

During the past twenty-five years, attention and study have been concentrated on this silver cyanide bath, primarily from the point of view of determining optimum operating conditions and finding the best additions to the bath in order to permit use of higher current densities and to produce an improved and "brighter" deposit[5]. The addition agents tried out include[6] gums, sugars, sodium thiosulfate, ammonium compounds (such as formates), aliphatic acids and derivatives (such as Turkey red oil), cyanate, thiourea and dithiocarbamates. The effects, on the deposit, of the presence of the more common salts, present intentionally or unintentionally, such as phosphates, sulfates, chlorides and hydroxides have also been determined[7]. The addition of potassium nitrate[8] has led to a plating bath of modified proportions of cyanide and carbonate, used in some industrial establishments.

The desire, and in at least one case[9], the necessity, of departing entirely from a cyanide bath (for example, to avoid its toxicity) has led to consideration of other complex

1. This was published originally as Preprint 80-35 of The Electrochemical Society, released Oct. 6, 1941.
2. Navy Dept., Bureau of Aeronautics, Washington, D. C.
3. R. Wallace & Sons Mfg. Co., Wallingford, Conn.
4. Frary, Trans. Electrochem. Soc. **23**, 62-97 (1913).
5. Egeberg and Promisel, Trans. Electrochem. Soc. **59**, 287 (1931) and bibliography therein.
6. Pan, Trans. Electrochem. Soc. **59**, 329 (1931); Ger. Pat. 627,559; U. S. Pat. 2,113,517; Glasstone and Saniger, Trans. Faraday Soc. **27**, 309 (1931); Egeberg and Promisel, Trans. Electrochem. Soc. **74**, 211 (1938).
7. Monthly Rev. Am. Electroplaters' Soc. (1937).
8. Wood, Proc. Am. Electroplaters' Soc. (1937).
9. French Pat. 704,663; Hickman, Weyerts and Goehler, Ind. Eng. Chem. **25**, 202 and 212 (1933).

ions of silver. Thus, we find silver baths made from silver iodide dissolved in potassium iodide to which compounds such as sodium chloride, calcium bromide or citric acid may have been added[10]. Thiourea-nitrate baths have been tried in Germany[11]. Finally, even in this last quarter century, some of the older trials with simpler salts have been repeated, notably with sulfate, nitrate, fluoborate and fluoride[12].

It is noteworthy, however, that in spite of all the laboratory and plant trials of various silver plating baths, the outstanding and almost universal bath in industrial use today is the bath containing silver cyanide, together with an excess of sodium or potassium cyanide, some sodium or potassium carbonate and small amounts of the brightener, carbon disulfide. It is on account of the superiority of this bath over all others tried, due to simplicity, stability, ease of operation, favorable electrochemical properties and attractive appearance of deposits, that it is the generally accepted silver plating bath today. We might add that the double cyanide bath containing potassium nitrate is in growing use.

The investigations today devoted to silver plating are not so much concerned in finding radically new types of solutions, though such work is in progress, as they are in modifying the present cyanide bath in order (1) to permit use of higher current densities with this bath without sacrifice in appearance of the silver deposits; (2) to improve the throwing power so as to secure better distribution of the deposit; (3) to control the corrosion of silver anodes; and, especially, (4) to apply mechanized equipment to silver plating such as plating machines, automatic filtration, anode and cathode agitation, and more efficient racking methods. It is from this study of mechanical details in particular that we may expect most of the progress in commercial silver plating in the near future.

Functions of Constituents of Bath

By far the majority of cyanide silver solutions are made with silver cyanide as the source of metal ions. Regardless of the manner in which silver enters the plating bath, whether through silver cyanide additions or through the dissolution of silver anodes, its solubility and degree of ionization depend upon the presence of sodium or potassium cyanide, which forms with the silver a soluble complex anion predominantly $Ag(CN)_2^-$. Chemical calculations are therefore based on a ratio of two molecules of the alkali cyanide to one atom of silver. The greater the excess of alkali cyanide (usually called "free cyanide") above that required to form the anions, $Ag(CN)_2^-$, the greater the decrease in the concentration of the silver cation. However, the customary silver cation concentration is essentially independent of small changes in the metal concentration within the usual bath operating range. Fig. 1 shows the approximate relation between static cathode potential and free cyanide concentration in baths containing silver cyanide and potassium cyanide only.

The electrical conductivity of the silver plating bath is commonly raised by the addition of sodium or potassium cyanide and sodium or potassium carbonate. None of these affects the conductivity only. The free cyanide, besides serving as a complex anion builder, increases the cathode

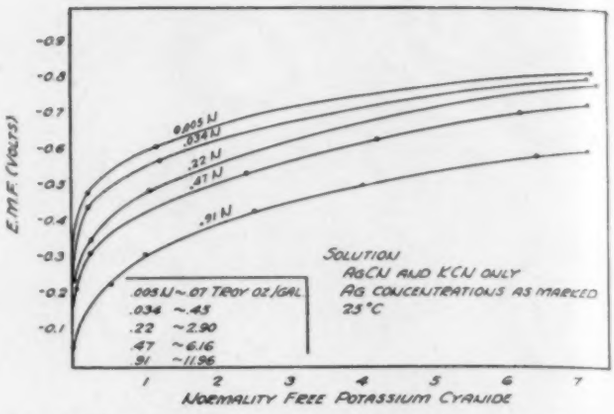

Fig. 1. Effect of free cyanide concentration on static potential (E_h).

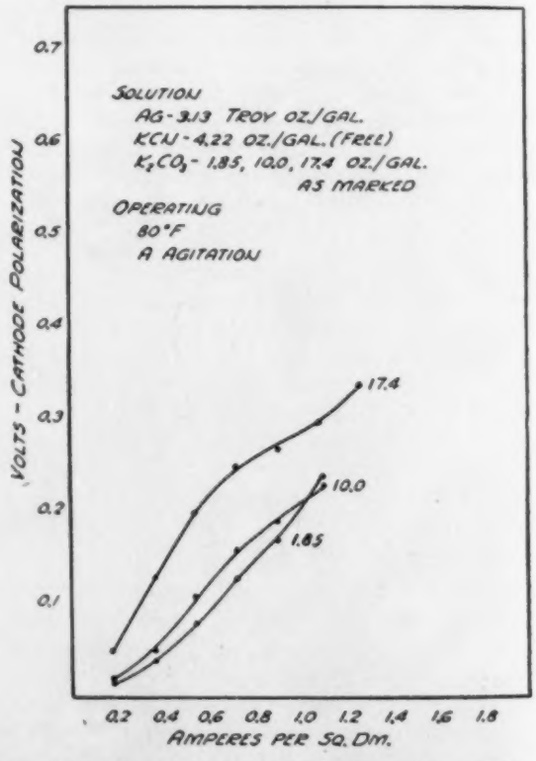

Fig. 2. Effect of carbonate concentration on cathode polarization.

polarization, makes possible good corrosion of the anodes and favorably affects the physical properties of the deposit. The carbonate also exerts an appreciable effect: It increases cathode and anode polarization, and also modifies the physical properties of the plate (see Fig. 2 and below). Some improvement in conductivity of the bath is caused by increasing the silver ion content, which simultaneously decreases cathode polarization (Fig. 3 and 4).

Of the other ions that occur in silver plating solutions, the two that have received greatest consideration are sodium and potassium, the relative merits of which have long been argued. It has been shown[13] that the cathode polarization at which so-called "burned" deposits occur is lower in sodium solutions than in potassium solutions (Fig. 5 and 6).

10. Brit. Pat. 333,462; Ger. Pat. 519,268; U. S. Pat. 1,857,664; Fleetwood and Yntema, Ind. Eng. Chem. **27**, 340 (1935).
11. Gockel, Z. Elektrochem. **40**, 302 (1934); U. S. Pat. 1,903,806 and 1,857,507; Brit. Pat. 443,428.
12. Sanigar, Trans. Electrochem. Soc. **59**, 307 (1931).
13. Egeberg and Promisel, Trans. Electrochem. Soc. **59**, 297 (1931).

This is one major reason for the general preference which exists for the potassium cyanide solution, since higher current densities and, therefore, faster plating are thus permitted with it. The solubilities of the respective carbonates are also important. Due to the much greater solubility of sodium carbonate in the silver plating bath at high than at low temperatures[14], difficulty is sometimes experienced whenever a plating solution high in this salt is allowed to cool. At such times, small crystals of sodium carbonate may form and anchor onto the cathode itself, causing faulty silver deposition. Another undesirable property of the carbonate ion is the tendency, when a slightly high concentration has been reached [38-75 g./L. (5-10 oz./gal.)], to cause an abrupt rise in cathode polarization upon a small decrease in bath agitation under otherwise normal operating conditions (Fig. 7 and 8). This condition frequently results in "burned" deposits. Because of the above objections, sodium carbonate is most safely held below 45 g./L. (6 oz./gal.), while the concentration of potassium carbonate may safely be permitted to reach 113 g./L. (15 oz./gal.). Since the latter is approximately the equilibrium value between dragout in commercial plating and chemical formation from cyanide[15], the advantage in this respect of using the potassium salt instead of the sodium becomes evident. Other advantages in using potassium rather than sodium salts are improved electric conductivity of the bath and brighter deposits that are more readily obtained. The only significant advantage in the use of sodium salts is the lower cost as compared with potassium.

One of the authors[16] has studied, under plant conditions, a series of argentocyanide solutions with various added anions and cations. These solutions were judged: (1) for uniformity of brightness of deposit when using carbon disulfide; (2) for simplicity of operation; and (3) for permissible current density range for normally semi-bright deposits. The following are the conclusions:

Cyanide Bath Composition	*Plating Results*
1. Additions of potassium carbonate, potassium sulfate, potassium nitrate	good
2. Additions of potassium chloride, sodium carbonate, potassium or sodium hydroxide	fair
3. Additions of sodium chloride, sodium nitrate	unsatisfactory

In cases where brightness of plate is unimportant or undersirable, even the above baths classed as "fair" or "unsatisfactory" for bright plating can be used successfully. The bath containing sodium and carbonate ions (as opposed to potassium and carbonate) is widely used under such conditions. Moreover, in the hands of especially skilful operators the sodium ion bearing bath is sometimes found to produce deposits as satisfactory as those from the preferred potassium ion baths.

No advantage is apparent in the use of the chloride ion in silver cyanide solutions, other than possibly an increased hardness of the deposit. In fact, the silver plating industry carefully excludes even small concentrations of chloride to prevent attack of steel in contact with the solution, such as steel tanks, steel anode supports, etc.

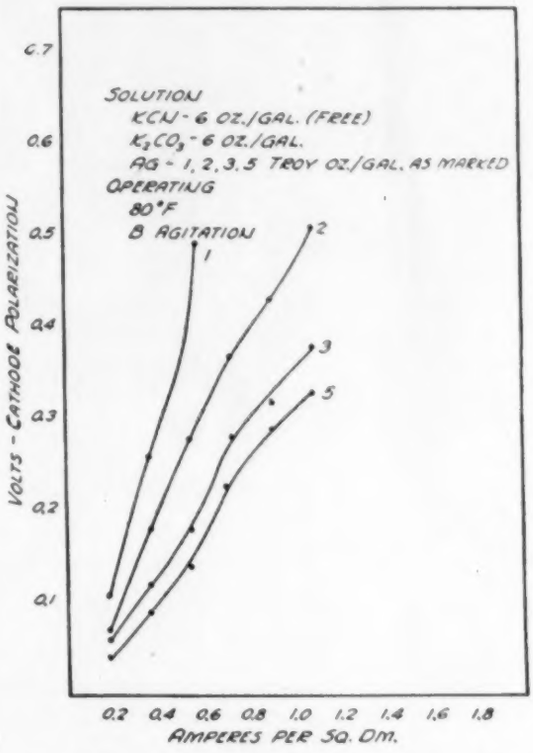

Fig. 3. Effect of silver concentration on cathode polarization. (Mild agitation of bath.)

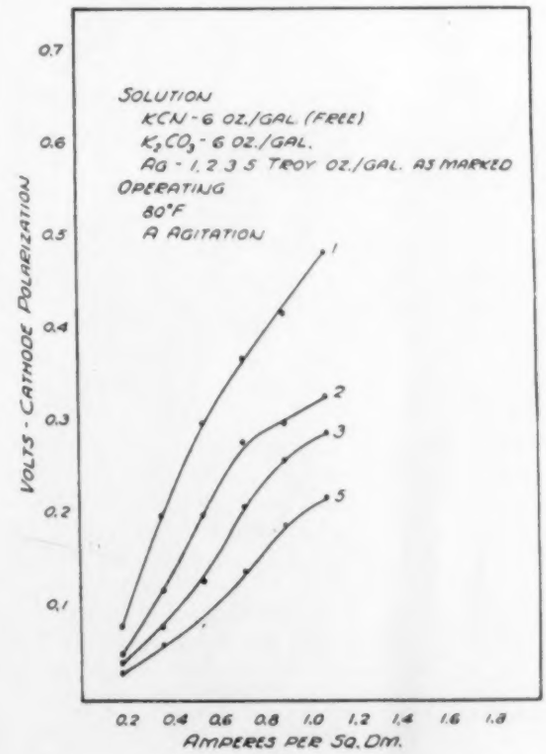

Fig. 4. Effect of silver concentration on cathode polarization. (Vigorous agitation of bath.)

14. This is a universally recognized fact but numerical values are not available. However, in pure water, sodium carbonate dissolves to the extent of 7.1% at 0° C.; and 45.4% at 100° C.

15. Carbonic acid from the atmosphere is absorbed by the bath and reacts to form carbonates:

$$2NaCN + H_2O + CO_2 = Na_2CO_3 + 2HCN$$

16. Proc. Am. Electroplaters' Soc. (1937).

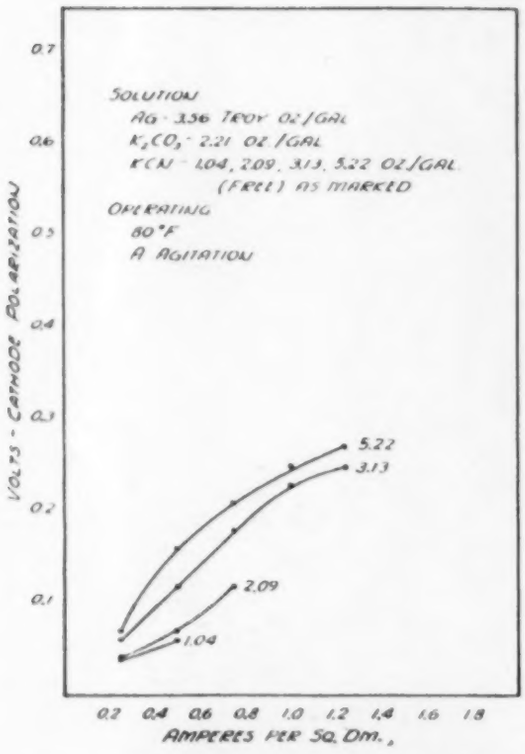

Fig. 5. Effect of free cyanide on cathode polarization. (Potassium cyanide solution.)

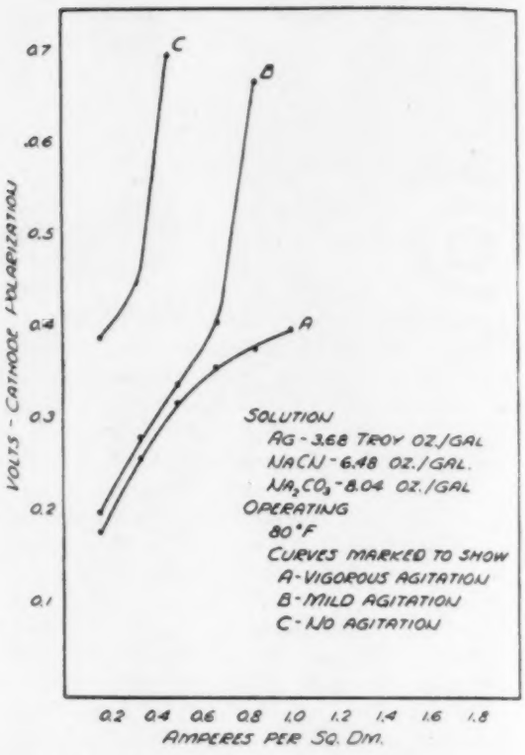

Fig. 7. Effect of agitation on cathode polarization. (Sodium cyanide bath.)

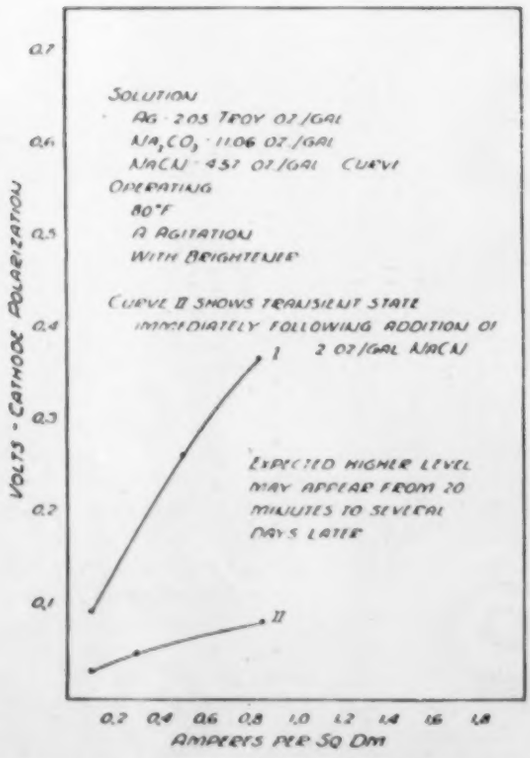

Fig. 6. Effect of cyanide addition on cathode polarization. (Sodium cyanide bath.)

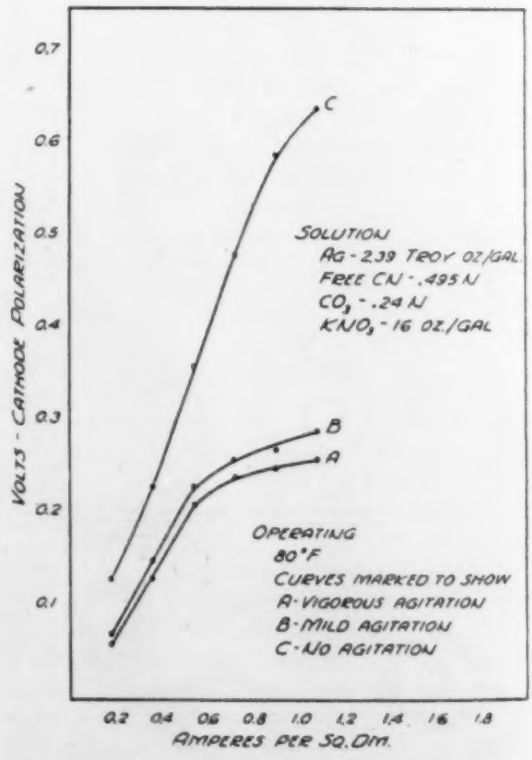

Fig. 8. Effect of agitation on cathode polarization. (Nitrate-cyanide bath.)

Aside from the above studies, the effect of other ions has also been investigated[17], the results indicating that formate, acetate, hydroxide, phosphate, and sulfate somewhat increase the hardness of the silver deposit, and that borate and chloride increase the hardness of the deposit very markedly. The cathode polarization in all cases was reported to be considerable.

It seems likely that the effect of these ions, phosphate, borate, etc., on the physical appearance of the cathode is associated with their influence on a colloidal substance derived from the carbon disulfide or its reaction products.

Carbon disulfide is the only addition or brightening agent known to the authors to be in current commercial use. It is invariably added to the bath as a solution or suspension made by taking a small sample of the plating bath or a fresh potassium cyanide solution and dissolving the carbon disulfide in it (Fig. 9 and 10). Although it is possible, using this brightener, to produce nearly mirror bright deposits under ideal conditions, it is more common practice to add only enough of the brightener to produce semi-bright deposits. Such deposits are finished with little more effort than is required for the brightest obtainable and even in the latter case some finishing or buffing operation is usually necessary anyway. On a single cathode of irregular shape such as a teaspoon, it is possible to have many degrees of brightness, varying, sometimes in sharply defined bands, with differences in agitation or current distribution. Because of such possibilities, it may be said that successful silver plating is largely a matter of arranging other factors to provide a suitable condition at the cathode for the most uniform effect of the brightener over the entire surface.

The most commonly used silver plating solution contains:

Silver (as metal)	25-33 g./L. (3-4 troy oz./gal.)
Free potassium cyanide	30-45 g./L. (4-6 oz./gal.)
Potassium carbonate	30-90 g./L. (4-12 oz./gal.)
Carbon disulfide brightener as needed	up to 0.9 mg./L. (0.0001 fl. oz./gal.)

A concentration of silver higher than 33 g./L. may be employed where the added cost is compensated for by higher limiting current density, which may be obtained under carefully regulated, favorable operating conditions. However, a large increase in silver content of the bath has an adverse effect on its throwing power and, to some extent, on anode polarization. On the other hand, below 25 g./L., of silver, a lower current density range becomes necessary; but this is sometimes acceptable where the resulting greater throwing power is required. Furthermore, a silver content below 25 g./L. may be advisable also in the interest of economy where large silver losses due to dragout constitute a serious problem.

Below 38 g./L. (5 oz./gal.) of free potassium cyanide, anode polarization rises rapidly, regardless of metal or carbonate concentration. More than 38 g./L. of free cyanide are usually required to maintain satisfactory anode corrosion. The free cyanide content may be raised appreciably above 38 g./L. without affecting the appearance of the silver plate; furthermore, throwing power is improved and higher current densities are permissible under otherwise favorable conditions. On the other hand, under some conditions, a large excess of free cyanide will reduce or completely destroy the effect of the brightener, carbon disulfide. A noticeable effect in the behavior of the brightener may be expected at a free cyanide concentration above 60-68 g./L. (8-9 oz./gal.). There are other bath variables beside free cyanide concentration that influence the behavior of the carbon disulfide.

Potassium carbonate is added when making up a new solution to improve the otherwise poor bath conductivity and to increase cathode polarization and resulting throwing power. Potassium carbonate is the normal decomposition product of potassium cyanide and its concentration tends to increase on continued operation and aging of the bath. As mentioned above, in the case of commercial installations potassium carbonate increases gradually up to the neighborhood of 113 g./L. (15 oz./gal.), at which approximate value it reaches an equilibrium between formation by decomposition and loss through dragout.

Solutions are frequently made with sodium cyanide and sodium carbonate where economy prohibits the more expensive potassium salts. The following concentration ranges are typical:

Silver (as metal)	25-33 g./L. (3-4 troy oz./gal.)
Free sodium cyanide	30-38 g./L. (4-5 oz./gal.)
Sodium carbonate	38-45 g./L. (5-6 oz./gal.)
Carbon disulfide brightener	0.9 mg./L. (0.0001 fl. oz./gal.)

The only major difference in desirable range of concentrations between this sodium cyanide solution and the potassium solution specified above is in the carbonate content. The undesirable effects of high concentrations of sodium carbonate have been described above. It may be noted that by limiting a silver plating solution to this lower total carbonate content, bath conductivity is sacrificed and throwing power of a lower order results.

Sodium salts, cyanide and carbonate, and not potassium salts, are used almost universally for "strike" solutions. The most common "strike" solution for basis metals other than steel contains:

Silver (as metal)	3-4.5 g./L. (0.4-0.6 troy oz./gal.)
Free sodium cyanide	60-90 g./L. (8-12 oz./gal.)
Sodium carbonate	8-30 g./L. (1-4 oz./gal.)

Below 3 g./L. of silver, a smutty, burnt deposit on high current density areas may result. At concentrations much above 4.5 g./L. of silver, the cathode current efficiency improves to such an extent that, for the short period usually involved in a "strike," little or no gassing may occur and the "strike" operation becomes nearly equivalent to that of a regular plating operation, and thus falls short of performing its desired "strike" functions. Large concentrations of free sodium cyanide, 90 g./L. and higher, cause very low cathode current efficiency, necessitating a longer striking time to obtain adequate or complete coverage. Concentrations of free cyanide below 60 g./L. reduce the normally high cathode polarization and high conductivity, and therefore cause poor covering power and throwing power. The sodium carbonate is sometimes added to a new "strike" to improve both factors, but more often the carbonate of the bath results from the decomposition of the cyanide in the bath.

Steel is now rarely plated directly with silver but when such is the case, a "first strike" is used, such as:

Silver	¾-1½ g./L. (0.1-0.2 troy oz./gal.)
Free sodium cyanide	60-150 g./L. (8-20 oz./gal.)

The combined effect of reducing the silver concentration of the first "strike" formula and of increasing the free

17. Glasstone and Sanigar, Trans. Faraday Soc. **27**, 309 (1931).

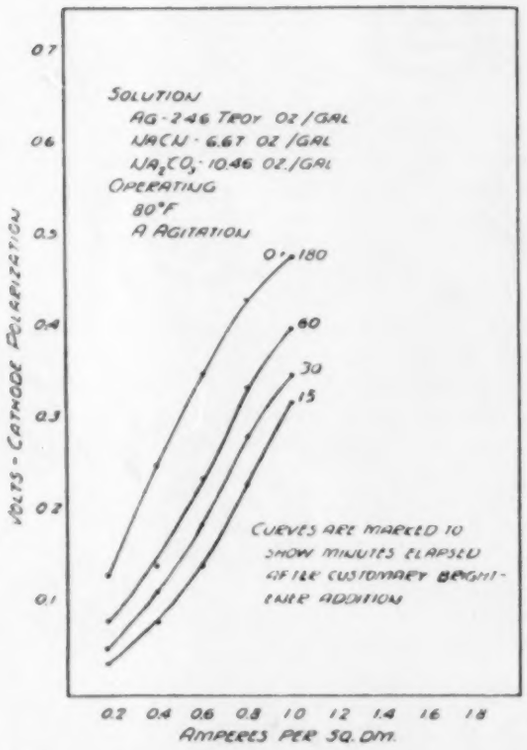

Fig. 9. Transient effect of brightener addition on cathode polarization. (Sodium cyanide solution.)

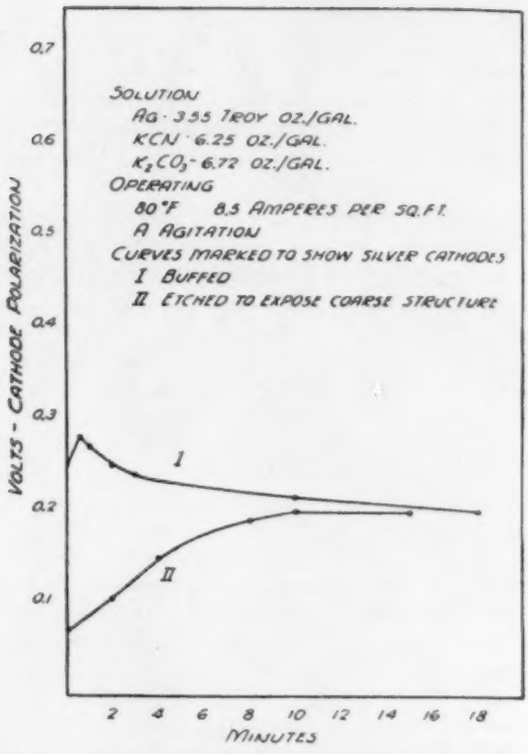

Fig. 11. Transient effect of basis metal on cathode polarization. (Potassium cyanide solution.)

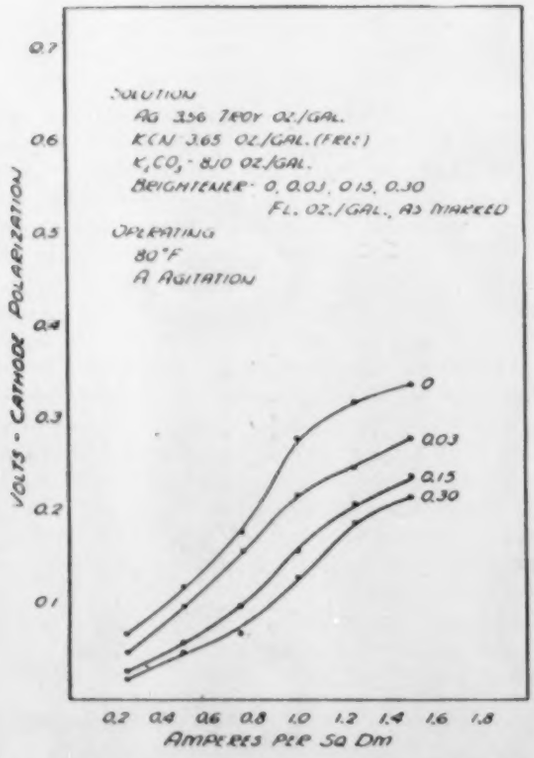

Fig. 10. Effect of brightener on cathode polarization. (Potassium cyanide solution.)

cyanide is to decrease the silver ion concentration to an extremely low value which supposedly insures good adhesion of the deposit on steel.

The following silver plating solution, which is slightly different from the conventional ones, is in limited but in increasing use today:

Silver (as metal)	16-18 g./L.	(2.0-2.3 troy oz./gal.)
Free sodium cyanide	15-22 g./L.	(2.0-3.0 av. oz./gal.)
Sodium carbonate	max. 22 g./L.	(Max. 3.0 av. oz./gal.)
Potassium nitrate	113-150 g./L.	(15-20 av. oz./gal.)

In spite of the lower range of silver concentration specified, the current density range is at least as high as with the higher silver concentration range in the conventional bath.

In potassium nitrate-cyanide solutions such as the above, anode corrosion appears to be due in part to the nitrate ion[18]. This allows a lower range of free cyanide concentration as against the nitrate-free baths, even in the presence of carbonate, which latter has an adverse effect on anode corrosion. In the presence of the nitrate, brighter deposits under favorable operating conditions are usually possible at or even below the lower limit of free cyanide specified. Satisfactory anode corrosion may be had at as little as about 7½ g./L. (1 oz./gal.) of free cyanide. Concentrations of free cyanide higher than 22 g./L. (3.0 oz./gal.) have no adverse effect except where maximum brightness is needed; they are accompanied by slight improvement in throwing power and covering power.

In principal, this nitrate-cyanide bath contains no carbonate to begin with. Carbonate is however formed in

18. Silver may be stripped electroytically from steel in a solution containing only potassium nitrate and ammonium hydroxide.
19. "Silver in Industry," Reinhold Pub. Co. (1940).

the bath and, at a concentration above about 22 g./L. (3 oz./gal.), maximum brightness is no longer obtainable. However, up to this value, 22 g./L., the carbonate may be considered as a tolerable impurity. When maximum brightness is unimportant, the presence of a higher carbonate concentration may be accepted as contributing to higher cathode polarization with improved throwing power.

In the nitrate-cyanide bath, the potassium nitrate has a beneficial effect on the appearance of deposits and on the operation of the bath. Sodium nitrate, on the other hand, when used in place of the potassium salt, produces a very undesirable plating solution. As in the case of carbonate, a low concentration of sodium ions may be tolerated, allowing the use of sodium cyanide at the low concentration required. In addition to contributing much of the total conductivity of the bath, potassium nitrate is the only source of potassium ions when sodium cyanide is used. For this reason, the potassium nitrate concentration must be kept high relative to the total sodium salt concentration.

Operating Conditions and Characteristics

The fairly recent advent of very high current densities in the commercial electroplating of most metals has not been paralleled in the case of silver, where very small gains have been made over older practice. The exact values of the current densities which continue to be used, predominantly in the range of 0.5 to 1.5 amp./dm.^{2} (5 to 15 amp./sq. ft.), depend upon whether a silver "strike" or a silver plating bath is used. In either case the current density depends somewhat on bath composition; also on the thickness of silver to be deposited; on the nature of the article; on the geometry of the set-up; on the amount and type of agitation employed; and on the temperature of the bath.

The temperature of a strike solution is always that of the room and there is always a certain amount of agitation due to the hydrogen gas liberated at the surface of the article being plated. This agitation is generally augmented, however, by a gentle rocking of the cathode itself. Under such conditions, the current density for the first five to fifteen seconds is in the neighborhood of 2.5 amp./dm.^{2} (25 amp./sq. ft.), and for articles not having deep recesses and prominent projections this period is often long enough for striking. Where a longer strike is desired, say, for about 1 to 3 minutes, the density is dropped to 1.5 amp./dm.^{2} (10 to 15 amp./sq. ft.) and where strike solutions are used to deposit a desired thin coating (without any further silver plating), the maximum current density is even lower than 1.5 amp./dm.^{2} In all cases, lower current density values may be used if the resulting decreased throwing power is acceptable.

In regular silver plating solutions, the range of current density is generally from 0.5 to 1.0 amp./dm.^{2} (5 to 10 amp./sq. ft.), at about 27° C. (80° F.). When relatively flat objects are to be plated and careful cathode racking is practiced, and the bath is properly agitated and general optimum conditions are maintained, the current density can be raised to 1.5 amp./dm^2. (15 amp./sq. ft.) and good plate obtained. It should be emphasized that all these current density figures are average ones, obtained by dividing the total current used for several or many objects racked in parallel, by the estimated total area being plated.

Higher current density ranges are possible by using potassium rather than sodium cyanide; by keeping the carbonate concentration (expressed as potassium carbonate) below 75-90 g./L. (10-12 oz./gal.); by cautiously adding carbon disulfide; by raising the bath temperature; by improving the rack design; and, within narrower limits, by improving the agitation of the bath. The most important factor of all of these is the increase in temperature, and it is often possible to increase the current density by 50% upon increasing the temperature by 11° C. (20° F.).

An increase in current density is accompanied by an increase in throwing power; by an increase in anode polarization; by an increase in cathode polarization (unless gassing occurs); and, up to a certain point, by an improved appearance of the silver deposit.

Most silver plating solutions are operated between 24° C. and 32° C. (75° and 90° F.). In fact, there is a strong tendency not to control the temperature, unless it drops much below 24° C. (75° F.), so that the above range usually does hold over both summer and winter. In some cases, a temperature near 35° C. (95° F.) may be employed. The higher bath temperatures are sometimes preferred because of possible higher cathode current densities and improved dissolution of the anode. However, the disadvantages of high bath temperatures also become more marked. They are: decreased brightness of deposit; more rapid loss of carbon disulfide with accompanying increased difficulty in controlling the solution and quality of plate; more rapid loss of cyanide[20] and thereby increase in carbonate concentration; and finally, associated with the last, an increase in obnoxious fumes. Consideration of these disadvantages has tended toward general adoption of a temperature range of 27° C. to 30° C. (80° F. to 85° F.).

Some attempts have been made to include a pH range in the specifications for commercial silver plating. The literature[21] contains recommendations of pH values in the neighborhood of 11.5 (colorimetric). Most cyanide silver plating solutions have a pH in the neighborhood of 11.5 to 12 (colorimetric using sulfo-orange indicator). Unpublished experiments by one of the authors, however, indicate that there is little to be gained from pH determination in silver plating and that, in fact, some confusion and erroneous deductions may result. The difficulty arises, at least partly, from the presence of the two alkali salts, cyanide and carbonate, which have marked and different effects on the plating results, but relatively about the same effect on the pH. Thus it is possible to secure two solutions of the same pH, one of which will give poor results; and, on the other hand, we may have two different silver solutions of different pH which will nevertheless give identical plating results. While there still exists the possibility of standardizing on a particular pH, measured after the solution has been corrected as to some of its ingredients, we believe that at this time there appears to be no advantage in thereby complicating the present simple and satisfactory control scheme applied to the silver plating baths.

The usual consideration of current efficiencies in the case of most metals is unnecessary in the case of silver plating, as under normal operating conditions both cathode and anode efficiencies are essentially 100%. In strike solutions, low cathode efficiency is to be expected but, aside from the problem of holding down the metal content of the solution, this is of little importance. With the plating solution having

20. The rate of decomposition of cyanide solutions at various temperatures has been studied by Wick, Proc. Am. Electroplaters' Soc. Phila. Convention (1932).

21. Hogaboom, Jr., Proc. Am. Electroplaters' Soc. (1937).

constant cathode efficiency, throwing power becomes a function of the solution conductivity and rate of change of cathode polarization, a condition relatively more simple than in most plating baths.

Compared to other commercial plating baths, the silver solution may be considered as having very good *throwing power*. At 27° C. (80 °F.) and at 0.7 amp./dm.^{2} (7 amp./sq. ft.) with a cathode distance ratio of 1 to 5 as determined in a Haring cell[22], a throwing power of a numerical value of 55% is normal for still silver solutions; and a value of 40% is expected with mild agitation of cathodes.

Due to very low cathode polarization, at which silver plating is usually accomplished, covering power is comparatively poor. Burning occurs at 0.5 to 0.7 v. cathode polarization, which means that average cathode polarization is of the order of 0.3 to 0.4 v. On low current density areas which consequently are areas of low cathode polarization, values of the order of 0.1 v. may become evident. Counter-potentials of this magnitude are experienced on multimetal cathodes and may result in failure to cover areas where the metal is less noble than that of the balance of the cathode, or on areas having a greater degree of oxidation or strain, such as may be caused by coarse grinding or cold working. Electrochemical phenomena in silver solutions are particularly susceptible to variation in agitation (Fig. 7 and 8), which causes more than the usual variation in cathode polarization and contributes to poor covering power. The common means of counteracting poor covering power of silver solutions is to insure complete coverage in the strike operation which is performed at higher average cathode polarization. If a heavy strike deposit is used to cover the areas exhibiting counter-potential, it is usually possible to complete the silver deposit in the plating solution without difficulty.

Measurement of cathode polarization in silver solutions is subject to difficulty and is rarely reproducible. A thorough study of the subject is yet to be made. Repeated observations make evident the trends to be expected by variation of the bath constituents and operating conditions, but the actual numerical polarization values we present in the tables and figures must be taken as semi-quantitative. Certain transient effects are recognized, even though not interpreted. To tentatively summarize the problem and to indicate phenomena which may become evident in plant operations, these polarization effects are shown in Fig. 2 to 11.

It is unnecessary to comment on the data presented in the curves other than to define the degrees of agitation (A, B and C) shown. Polarization measurements with agitation were made by operating a variable-speed rotating stirrer in the cathode compartment of a modified Haring cell. As the speed of the stirrer is increased, the cathode polarization falls progressively up to a point at which further increase in stirrer speed causes no further decrease in polarization (Fig. 7 and 8). This is called "A" agitation. It is characteristic of this degree of agitation that, when the current is interrupted, the potential of the cathode, as checked with a half-cell, returns to the static value instantaneously or within one second (Fig. 1). When the return to static potential requires 1 to 5 sec., the degree of stirring is called "B" agitation. With no stirring, shown as "C" agitation, complete return to static potential may require 5 to 10 sec. or much longer.

The resistivity of silver plating solutions will fall ordinarily between the values 5 ohm/cm.^{3} and 20 ohm/cm.^{3} All of the salts contained in the bath contribute to the resultant value, carbonate and cyanide about equally above a concentration of 15 to 23 g./L. (2 to 3 oz./gal.) and silver to a lesser degree except in the case of solutions having specific resistivities above about 15 ohm-cm.

The numerical values in Tables I, II and III indicate the relative magnitude of the effects of the various ingredients. Only the concentrations of the variables are given, the concentrations of the other ingredients being of the usual order of magnitude.

TABLE I

Effect of Potassium Carbonate on Resistivity

Potassium carbonate	oz./gal.	1.9	10.0	17.4
	g./L.	13.9	75.0	130
Resistivity	ohm./cm.^{3}	9.6	6.2	5.0

TABLE II

Effect of Free Cyanide on Resistivity

Free sodium cyanide	oz./gal.	1.0	4.0	6.0
	g./L.	7.5	30	45
Resistivity	ohm./cm.^{3}	14	11	9

TABLE III

Effect of Potassium Nitrate on Resistivity

Potassium nitrate	oz./gal.	0	10	16	20
	g./L.	0	75	120	150
Resistivity	ohm./cm.^{3}	17.5	9	6.6	5.9

It will be noted that resistivity may be reduced appreciably with small additions of salts when the original value is high. As the resistivity decreases, the amount of added material required to reduce it further becomes comparatively greater. The literature shows no evidence of silver baths having resistivities below the vicinity of 5 ohm-cm. at normal temperatures. This is evidently near the limiting value and solutions are planned to approach it as closely as other factors demand or allow.

Where resistivity measurements are not feasible, an approximation of this characteristic may be obtained by means of an hydrometer reading. Baths having specific gravities above 1.120 (15.5 Bé.) will generally have specific resistivities between 6 and 5 ohm-cm.

Maintenance and Control

In silver plating baths, as in other baths, filtration of the bath is resorted to as a specific cure or treatment for rough deposits. Periodic filtration is a common preventive measure, with intervals varying from six months in some plants to one month in others. Where frequent filtration is practiced, it is usually directed toward removal of particles of colloidal dimension or close to it. For this purpose, a filter-aid, generally diatomaceous earth, is used. This type of filtration is based on and supports the theory that carbon disulfide brightener produces a solid colloid phase in solution. When brightness of plate falls off in spite of the usual brightener additions, and under otherwise normal conditions, filtration with diatomite is resorted to, to remove the agglomerated solid colloid product. By this procedure the normal colloid phase is likewise removed, as is indicated by the fact that a plating solution producing bright deposits ceases to do so after diatomite filtration. Furthermore, the plating solution again performs normally, producing acceptable bright plate, upon adding fresh quanti-

22. Trans. Electrochem. Soc. 44, 313 (1923).

ties of carbon disulfide after diatomite filtration. Continuous filtration, coupled with continuous brightener addition, appears to be a logical and desirable procedure. That this is not in general use may be due to the difficulty of avoiding introduction of air into the bath during filtration. Air has a distinctly undesirable effect in tending to produce pitting of the silver deposit. Furthermore, filtration must necessarily be thorough and rapid for, if not, stirring up residual particles during filtration will usually give rise to rough silver deposits.

In most plants, there is no serious problem in silver plating, as there is in nickel plating, due to the presence of impurities. Although little is known of the effect on silver plate of foreign metals, no difficulties are traced to any, with the possible exception of iron. This metal may reach a high concentration in the plating bath and has been observed to cause a yellowish tint in the silver deposit.

There is no method known to the authors for removing impurities by electrolysis of the silver solution. Low temperature is commonly applied to the bath to reduce the sodium carbonate concentration in sodium cyanide baths. At the same time, the iron concentration can be lowered by crystallization and removal of the iron as the ferrocyanide. Due to its higher solubility at low temperature, potassium carbonate is not amenable to the same treatment as sodium carbonate. The use of calcium sulfate[23] is a potential means of reducing carbonate in potassium cyanide solutions, but, perhaps because it is considered unnecessary to remove potassium carbonate, or because the exchange of sulfate for carbonate introduces an unexplored problem, this calcium sulfate method has not found general acceptance in the silver plating industry. In the potassium nitrate-cyanide solution, the carbonate is readily removed by precipitation with calcium nitrate.

Filtering through activated carbon has been observed to "remove certain cumulative impurities not removed by other filtering processes" but cannot be said to be in general use.

In silver plating practice today, the maintenance and control of the baths are based primarily on chemical analyses and on the appearance of the deposit. The former determines the maintenance and control of the concentration of silver, free cyanide, carbonate and metallic impurities. Physical appearance of the plate determines the addition of carbon disulphide, which is the only other bath ingredient ever considered.

The only other tests occasionally made on silver plating solutions are the determination of cathode and anode polarization. These tests are usually made in a Haring cell[24] at the usual operating temperature and range of current density. Such tests, however, are not of the routine type, but are rather special, being of assistance in determining the cause of occasional plating results which are unsatisfactory without apparent cause. As general criteria in these tests, maximum figures of about 0.2 v. for anode polarization and about 0.5 v. for cathode polarization are normal. If values found are unusually high, an attempt is made to correlate them with excessive carbonate in solution, or with low free cyanide or with other analytical data.

The United States Bureau of Standards' Research Paper #384 adequately covers methods of analysis for silver plating solutions. Routine control usually involves determination of silver, free cyanide, and carbonate only. The specific gravity of the bath is sometimes measured to indicate the total salt content of the bath, which in turn gives an approximation of bath resistivity. A potentiometric method for determining silver and free cyanide, by direct titration with silver nitrate, has been proposed[25]. The common methods are as follows:

1. *Free Cyanide*

To a 20 ml. sample of the plating solution add 0.1 g. of potassium iodide (or 0.2 g. for badly contaminated solutions). Dilute to 250 ml. and titrate with 0.1 *N* silver nitrate solution. The endpoint of the titration is the first appearance of opalescence, best observed with a black background.

1 ml. 0.1 *N* $AgNO_3$ = 0.00980 g. NaCN or 0.01302 g. KCN

2. *Silver*

Treat 10 ml. of plating solution with 20 ml. of concentrated sulfuric acid. Evaporate to fumes of sulfuric acid in a well ventilated hood. Add a few drops of concentrated nitric acid, if necessary, to hasten decomposition of organic matter and reevaporate to fumes; cool, dilute to 150 ml., and warm until all solids are dissolved. Add 3 ml. of saturated ferric ammonium alum solution and titrate with 0.1 *N* potassium thiocyanate to the appearance of a pink coloration.

1 ml. 0.1 *N* KCNS = 0.01079 g. Ag

3. *Carbonate*

To the solution resulting from the Liebig titration for free cyanide (procedure 1) add a few drops of phenolpthalein solution and titrate with 0.5 *N* hydrochloric acid until the pink color is completely discharged.

1 ml. 0.5 *N* HCl = 0.0530 g. Na_2CO_3 or 0.0691 g. K_2CO_3

Agitation of the Bath

In silver plating solutions the normal tendency toward stratification is particularly objectionable. Continuous or daily stirring is common practice to limit the effect of this phenomenon.

Anodes

Silver is very easily soluble anodically in solutions containing any appreciable concentration of cyanide ions. Silver is also soluble chemically in such solutions if an oxidizing agent such as air is present. Except in a few cases to be mentioned below, pure silver anodes are almost universally used in silver plating. Their dissolution at practically 100% current efficiency under normal operating conditions makes the replenishment of silver in the bath by this method ideal, for the cathode current efficiency (also 100%) is thereby counterbalanced. The slight chemical attack of the silver anodes tends to replace that additional amount of silver lost by dragout. The exceptions referred to above include the use of silver-gold anodes in the electrolytic parting process; the use of insoluble anodes (steel) in the deposition of silver purely for the reclamation of the metal; and the use of insoluble anodes together with silver anodes in some silver strike solutions, where, due to the low cathode current efficiency, the silver content of the bath will increase excessively if silver anodes alone are used. The insoluble anodes used include platinum, carbon, and stainless steel, the choice depending upon the particular application.

23. Dupont Carbonate Remover.

24. Haring and Blum, Trans. Electrochem. Soc. **44**, 313 (1923).
25. Weiner and Schmidt, Z. Elektrochem. **46** (4), 49 (1940).

The silver metal used for anodes must be very pure. The plating trade in this country is furnished with silver anodes 999.5 + fine. The 0.05% (maximum) of impurities must, however, be designated very carefully, as will be evident from the discussion of "black anodes" below. The almost universal anode shape or form is the rolled silver strip, cut to the consumer's specified sizes. The general practice today is to give the silver strip a final high temperature anneal after rolling. Aside from the effect of this anneal on the formation of black anodes during electrolysis, the grain size of the metal is also affected, as will be discussed further below. Before a new anode is suspended in the plating tank, it is, in some plants, surface cleaned. As a rule this is not necessary.

Perhaps the most important anode problem in large-scale silver plating is the tendency to form so-called "black anodes." However, these black anodes are rapidly disappearing, as knowledge of the cause for their occurrence accumulates. In normal dissolution or corrosion of silver anodes, the anode surface appears matte or dull and of a very light gray color. Under some conditions, however, the surface color of corroding anodes is much darker, even becoming black, and a fairly tenacious and adherent scum appears. It is this condition of the anodes, of varying intensity, that is referred to as "black anodes." The black scum or film, aside from retarding anode corrosion, tends to loosen at certain points of the surface of the anode and portions of the scum insoluble in the plating solution become suspended in the bath, migrate to the cathode, and cause formation of rough silver plate. If these scum specks are removed in subsequent polishing, pits in the silver plate result.

The conditions under which "black anodes" are formed and the composition of the film have long been studied. It now appears certain that the major cause for "black anodes" is the presence in the anodes of certain impurities which in themselves are not soluble in the plating solution and/or which do not form salts readily soluble therein. These impurities, which total a maximum of 0.05%, are most frequently, but not exclusively, lead, iron, bismuth, manganese, tellurium, selenium, sulfur and antimony. Under conditions of high anodic current density or relatively low concentration of free cyanide the selective dissolution of silver from the anode leaves a high surface concentration of these undesirable elements or their salts. Low anode current density, high concentration of free cyanide or periods of idleness of the anode permit the slow but definite dissolution of most of these impurities or their products as they are formed. It has been suggested[26] that high temperature annealing of the rolled silver, followed by quenching, might retain these impurities dissolved in the silver grains and thus prevent their segregation at the grain boundaries, in which concentrated formation they do most harm. Such quenching has, in fact, proved beneficial in some cases and its efficacy may depend on the solubility in the plating solution of the metallic silver alloy or compound formed. The concentration of impurities in the grain boundaries depends, of course, on the surface area of these boundaries and therefore on the crystal size. For this reason, grain size may affect anode corrosion indirectly, and in anodes of questionable purity a preference for a fine grain (and therefore more grain boundary area and lower concentrations of impurities) should be specified. In the case of anodes made of 999.9 fine silver or better, grain size does not appear to be an important factor.

A contributory cause of "black anodes" is improper solution composition. The desirability of having a relatively high concentration of free cyanide has been mentioned. The formation of "black anodes" can be caused by a high iron content in the plating solution. The literature[26] attributes the formation of "black anodes" to the presence of sulfide and thiocyanate in the bath.

Anode Current Density. Modern practice in silver plating is to use an anode current density rarely exceeding 1.0 amp./dm.^{2} (10 amp./sq. ft.). This corresponds roughly to a ratio of anode to cathode area of not less than 1:1. Under these conditions, the anodic polarization is in the neighborhood of 0.1 to 0.2 volt. If the polarization exceeds this appreciably, reaching for example 0.5 volt, then the proper electrochemical conditions obtain for developing black anodes. The addition of sodium or potassium cyanide reduces this polarization voltage as does the removal of carbonate from solution. The presence of carbon disulfide in the bath has little effect on anodic polarization, tending, however, to increase it.

Preparation of Basis Metals

There are three problems in silver deposition which require consideration in preparing the basis metal. These are:

1. The possibility of deposition by immersion or replacement, with poor adhesion of plate as a result.

2. The difficulty of covering solder or other areas having potentials opposed to the silver deposition potential and easily exceeding the low limiting silver polarization potential in normal plating operation.

3. The tendency of the silver deposit, under certain conditions, to reproduce macroscopically the surface structure of the basis metal, which necessitates a finishing problem.

In some cases all three problems may be solved by the use of one or more silver "strikes" preceding the plating operation. The strike solution has a lower silver ion concentration than the plating bath and therefore reduces the tendency to plate by immersion. The lower cathode efficiency of the strike operation introduces cathodic reduction by hydrogen which, in turn, assists toward good adhesion even when slight deposition by immersion is known to occur. A higher average cathode polarization voltage is possible in the strike, which is perhaps due to the selective stirring effect of the hydrogen gas bubbles at the high current density areas, which stirring lowers the tendency to burn, at least for the short period involved. If the strike operations result in masking the basis metal influences with a relatively heavy silver deposit applied at high potential, satisfactory deposition may follow in the plating solution. If the strike deposit is not heavy enough or if it, too, has failed to compensate for the basis metal influences, then part of the strike deposit of silver may be found to have dissolved during the subsequent plating operation and, on the otherwise well-plated cathode, the "counter-potential areas" emerge from the bath unplated; or, under the same conditions, a thin silver plate will cover the basis metal but reproduce its surface structure, particularly at the low current density areas.

It is not always possible to obtain satisfactory adhesion and coverage by the use of a silver strike alone. In preparing copper and brass articles for the silver plating bath, a mercury dip often precedes the silver strike and results

26. Thurber, Gray, Sholtz and discussers, Trans. Electrochem. Soc. 74, 255 (1938).

in improved adhesion. Undercoats of nickel or of tin are also used to prevent deposition of silver by immersion and to mask basis metal influences. Nickel and tin are usually preferable to mercury, especially if it is possible to secure satisfactory coverage at low cathode efficiency, in which case cathodic hydrogen, if not excessive, will assist in producing good adhesion of the intermediate deposit of nickel or tin.

Tests of Deposits

Probably because of the intrinsic value of silver metal, "specification plating" was a commonplace in the silver plating industry long before plating standards were adopted in the plating industry as a whole. This explains, no doubt, why there are no American Electroplaters' Society's or American Society for Testing Materials' specifications in force in commercial silver plating.

Flatware is generally silver plated on a basis equivalent to so many troy ounces of silver per gross of teaspoons. The usual weights of silver on spoons are:

Federal Specification Plate	280 g. or 9 troy oz./gross of teaspoons
Quadruple	250 g. or 8 troy oz./gross of teaspoons
Triple Plate	187 g. or 6 troy oz./gross of teaspoons
Double Plate	124 g. or 4 troy oz./gross of teaspoons
Standard Plate	62 g. or 2 troy oz./gross of teaspoons
Half-plate	31 g. or 1 troy oz./gross of teaspoons

Other items of flatware are plated with weights of silver in the same ratio to that of the teaspoon as the ratio of surface areas. So-called "fancy" or serving pieces are sometimes plated at lower weights than are accompanying "staple" pieces, in view of the lighter use expected.

Additional "spot-plates" or overlays are sometimes applied at one or more points of maximum wear, 47 g. or 1½ troy oz./gross being the greatest weight, known to the authors, to be added in this form.

Cutlery is plated on a basis equivalent to so many pennyweights of silver per dozen solid-handle dinner knives, plated all over. The usual weights for cutlery are:

Hotel Plate	31.1 g. or 20 dwt./doz. dinner knives
Federal Specification Plate	26.4 g. or 17 dwt./doz. dinner knives
Heavy Plate	24.9 g. or 16 dwt./ doz. dinner knives
Standard Plate	18.7 g. or 12 dwt./doz. dinner knives

As in the case of flatware, smaller knives, and those on which only the handle is plated, are plated with weights in proportion to the area and silver weight for dinner knives.

Hollow ware silver plating is not as well standardized as are flatware and cutlery. A Federal specification exists,[27] and hotel hollow ware is handled with fair uniformity by the larger manufacturers, but the commercial grades, including such items as tea sets, sandwich plates, trays, candy dishes, etc., lack even the nomenclature of standardization, except by the individual manufacturer. The following values indicate the weights generally employed for hollow ware:

Federal Specification Plate	20 dwt./sq. ft. (33.5 mg./cm.²)
Extra Heavy Hotel Plate	15 dwt./sq. ft. (25.1 mg./cm.²)
Heavy Plate	10 dwt./sq. ft. (16.8 mg./cm.²)
Medium Plate	5 dwt./sq. ft. (8.4 mg./cm.²)
Light Plate	2 dwt./sq. ft. (3.4 mg./cm.²)

A deposit of silver weighing 20 dwt./sq. ft. (33.5 mg./cm.²) has an average thickness of about 0.032 mm. (0.00125 in.). This thickness is the basis for the Federal specifications shown above, from which other thicknesses may be estimated.

The porosity of silver deposits has not greatly concerned the industry. The recent investigation of silver as a coating material for food containers made the question somewhat more important, especially when using steel as a basis metal. When silver is deposited on steel, it may be tested for porosity by the application of "ferroxyl" gel,[28] which reacts blue to show the exposed iron. When silver is plated on copper or its alloys, the gel may be modified by the addition of ferrocyanide to indicate exposed copper.

Because the thickness of a silver deposit is most commonly specified in terms of weight, tests for thickness are usually made by stripping the entire deposit. The piece is weighed before and after stripping and the surface area determined to allow calculating the pennyweight of silver per square foot (or milligrams per square centimeter). In the case of silver plated steel or Britannia metal, the deposit is stripped anodically in sodium cyanide solution. From nickel-silver, brass or copper, the silver is dissolved in a mixture of 19 parts of concentrated sulfuric acid to 1 part of concentrated nitric acid at a temperature of 80° C. (176° F.).

When a direct thickness measurement is required, the Mesle chord method[29] is used; or the determination is made by preparing a cross section of the plated article for observation and measurement under the microscope. On steel, the magnetic method[30] is applicable.

Deposits are rarely tested for physical properties except by the practical criticism of their finishability. A deposit which can be readily brought to a high luster by buffing is considered a good deposit and conversely a deposit which requires undue effort in finishing is poor.

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27. Federal Specification RR-T-51a.
28. Simon and Lumley, Proc. Am. Electroplaters' Soc. (1940).
29. Mesle, Metal. Ind. (N. Y.) **33** (1935); J. Research Natl. Bur. Standards **16** (Feb., 1936); RP 866.
30. J. Research Natl. Bur. Standards (May, 1937); RP 994.

Chromium Plating of Brass

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Introduction

IT is generally conceded in the plating industry today that chromium, plated directly upon brass,[1] in the thickness usually applied for decorative coatings, is an unsatisfactory solution to any finishing problem.

With the present situation as to available nickel for decorative plating, it becomes apparent that every possibility must be investigated and a new sense of values established to carry us through the duration of our emergency.

Therefore we set forth upon a project to search out all corners of this problem of chromium plating upon brass; first to determine some measure of relative value between a chromium plated brass article with the usual nickel undercoating and the same article without the protection of nickel; secondly, we wanted to find if possible, the reason for the rapid failure in chromium plate directly on brass (the common effect of flaking and cracking on sheet brass) and to improve this condition if at all possible.

This paper is a report of our findings in tests which began early in June of 1941 and are still under operation. We have brought out several rather interesting results which may lead to the satisfactory use of chromium on brass from the standpoint of adhesion, and adds further proof to the unsatisfactory consideration of chromium as a corrosion protective coating.

Preparation of the Samples

Two types of base metal were selected for use as samples: the common alloy, high zinc brass tubing, and a cast alloy of 78% copper, 2% lead, with balance zinc. Both of these types received the same preparation for testing.

Following is the plating cycle for the samples which received a nickel undercoating:

1. Degrease in trichloroethylene
2. Alkaline electroclean as cathode—30 sec. at 200° F.
3. Alkaline electroclean as anode for 15 sec. at 200° F.
4. Rinse
5. Acid dip in 15% HCl (by volume)
6. Rinse
7. Copper strike—Rochelle copper-30 sec.
8. Rinse
9. Acid dip—20% H_2SO_4 (by volume)
10. Rinse
11. Nickel plate—organic type bright nickel
12. Rinse
13. Alkaline electroclean as cathode for 15 sec. at 200° F.
14. Acid dip in 20% HCl (by volume)
15. Rinse
16. Chromium plate (250 g./l. solution with 100:1 sulphate ratio)
17. Rinse

R. B. Eyre

Following is the plating cycle of samples plated direct with chromium:

1. Degrease in trichloroethylene
2. Alkaline electroclean as cathode for 30 sec. at 200° F.
3. Alkaline electroclean as anode for 15 sec. at 200° F.
4. Rinse
5. Acid dip in 20% HCl (by volume)
6. Rinse
7. Chromium plate (250 g./l. solution with 100:1 sulphate ratio)
8. Rinse

We decided to place on test, samples of both cast and wrought brass which were copper plated and chromium plated without nickel to see if there was any pronounced effect in protection or adhesion. Below is the plating cycle for those samples:

1. Degrease in trichloroethylene
2. Alkaline electroclean as cathode for 30 sec. at 200° F.
3. Alkaline electroclean as anode for 15 sec. at 200° F.
4. Rinse
5. Acid dip—15% HCl (by volume)
6. Rinse
7. Copper plate—Rochelle copper
8. Rinse
9. Dip in 20% H_2SO_4 (by volume)
10. Rinse
11. Alkaline soak clean for 30 sec. at 200° F.
12. Rinse
13. Acid dip in 20% HCl (by volume)
14. Rinse
15. Chromium plate (250 g./l. solution with 100:1 sulphate ratio)
16. Rinse

None of our samples was color buffed after plating as we wanted to be sure to remove the possible error of grease films left on the samples when tested. They were thoroughly rinsed in clean water and wiped dry with a clean cloth.

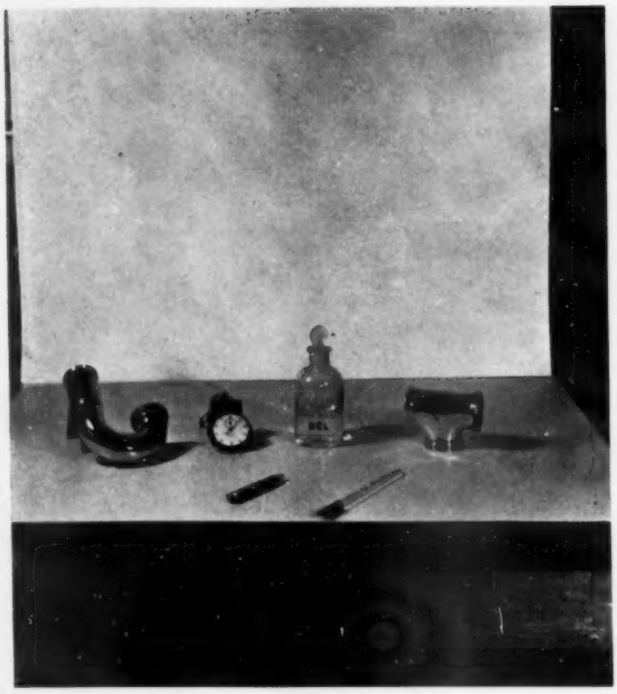

Fig. 1. "J"-bends and "T's" in preparation for determination of thickness of chromium by means of the "spot test".

Method of Thickness Determination

The tubular brass parts were formed into a standard plumbing fixture commonly called by the trade "J-Bends" (see Figure 1). As they were exposed to a rather wide variation in current density, we made thickness tests on these parts at both low and high current density areas.

The cast parts were standard "1½" tees" and were tested in a spot which we determined was relatively average of the current density (see Figure 1).

The thickness tests for chromium were made by the "Spot Test." A drop of concentrated HCl was placed on the pieces and timed with a stop watch for gas evolution.

The nickel thickness was measured with a Magne-Gage and the copper thickness by microscopic measurement (see Figure 2).

Thickness of Coatings on "1½"-Tees"

Thickness in Inches.

Number of Sample	*Copper*	*Nickel*	*Chromium*
1	Flash	.00025	.000009
2	Flash	.00026	.000012
3	Flash	.00008	.00001
4	.0001		.000024
5	.0001		.00001
6	Flash		.000032
7	Flash		.00001
8			.000035
9			.000028
10			.000018
11			.00001
12			.00008

Salt Spray Exposure Tests

Samples of each of the twelve types of coatings for both cast and wrought brass were tested in a salt spray cabinet with the hope that we could establish a set of relative values for the different types and thicknesses of coatings.

Salt spray cabinet used to make accelerated corrosion tests.

It is believed, through experience in the past, that plumbing fixtures (with the exception of faucets and drains which are wearing parts) have an average life of somewhere near twenty years. It is also thought that for the first ten years of this life, the finish is relatively good and is acceptable to the general public. We, therefore, hoped to estimate the life of a part which is not nickel plated in terms of one which carries our standard thicknesses of nickel and chromium. This perhaps was "wishful thinking" but we felt it had enough merit to warrant the test.

Thicknesses of Various Coatings on "J-Bends"

Thickness in Inches.

Number of Sample	*Copper*	*Nickel*	*Chromium*
		*H-.00025	H-.000008
1	Flash	*L-.00012	L-.000004
		H-.00017	H-.000013
2	Flash	L-.00009	L-.000009
		H-.00007	H-.00001
3	Flash	L-.00004	L-.000005
			H-.00002
4	.0001		L-.000007
			H-.000008
5	.0001		L-.000003
			H-.00002
6	Flash		L-.000006
			H-.000008
7	Flash		L-.000004
			H-.000033
8			L-.00001
			H-.000024
9			L-.000008
			H-.000014
10			L-.000006
			H-.000008
11			L-.0000032
			H-.000072
12			L-.000035

*H = High current density area
*L = Low current density area

Samples were exposed to a 20% salt spray at 8-10 pounds pressure. The temperature of the cabinet varied between 85-90° F. during the tests.

Failures began to appear after 51 hours of exposure. The first failures were on samples that had no nickel undercoating (wrought brass) and while there was a few hours difference between the appearance of the failure on the different samples we were unable to see any advantage of one part over another regardless of the thickness of copper plate or chromium plate. Also, the time of failure of cast

and wrought brass samples seemed indistinguishable.

All failures showed the same effect—that of pin point spots of green and blue corrosion products. The adhesion of the chromium plate remained good throughout the test. There was no evidence of cracking or flaking of the chromium.

The first failure of a part which had a nickel undercoating occurred after 180 hours of exposure. This was sample No. 1 of the wrought brass and within five hours, sample No. 2 of the cast brass also failed.

If we would allow ourselves to compare these failures, we would see that parts with even .0001" of nickel undercoating are 400% better than chromium plated direct. When we exposed samples to outdoor conditions (as will be explained later) we find that relatively, the nickel undercoated samples were far better than the chromium direct.

Conclusions from Salt Spray Tests

From the results of the salt spray exposure we felt justified in believing that chromium, with or without a copper plate, when plated on either cast or wrought brass, gave very little corrosion protection. This conclusion takes into consideration only the thinner coatings of chromium ordinarily used for decorative purposes. This result did not surprise us as it has been fairly well established by many others in the past. It merely confirmed our thoughts and cleared the decks for further study.

Outdoor Exposure Tests

Several samples of each of the twelve types of coatings were placed on a rack in such a position as to insure quick and easy drainage of rain, dew, etc. (see Figure III).

This rack was placed on the roof of our plant in such a way as to expose it to the full effects of sun, rain, dew, smoke, etc., at all times.

Below is a chart of the behavior of these samples as they were examined at the end of each week.

Weather Tests on Chromium Plated Brass
High Brass Tubing—"J-Bends"

Number of Samples	*End of 1st Wk.*	*End of 2nd Wk.*	*End of 3rd Wk.*	*End of 4th Wk.*
1	O. K.	O. K.	O. K.	O. K.
2	O. K.	O. K.	O. K.	O. K.
3	O. K.	O. K.	O. K.	O. K.
4	O. K.	Tiny "Spider-Web" * cracks in Cr plate. Plate still firmly adherent.	Increase in number of cracks so that every ¼ sq. in. was broken by cracks—plate still adherent.	Further increase in cracks with small amount of white corrosion salts in cracks — plate still adherent.
5	O. K.	O. K.	O. K.	Spider-web cracks beginning to appear.
6	O. K.	O. K.	Cracks in sample appearing as in 4.	Increase in cracks—looks same as sample No. 4.
7	O. K.	O. K.	Cracks as in sample No. 4 appearing.	Increase in cracks—looks same as sample No. 4.
8	O. K.	O. K.	O. K.	Cr plate is beginning to lift at points where cold working of brass has left a stress in the base metal. (Determined by mercury test.)
9	O. K.	O. K.	O. K.	This sample shows same condition as in sample No. 8.
10	O. K.	O. K.	O. K.	Shows same as No. 8.
11	O. K.	O. K.	Some pinpoint spots of brass showing through. Balance of plate adherent.	Many pinpoint holes in Cr plate. Plate easily flaked off by rubbing with hand.
12	O. K.	O. K.	O. K.	Beginning to show same results as 11 but only to a very small degree.

* The "spider-web" cracks appeared in fine white lines criss-crossing each other every ¼ to ⅛ inch. They were uniformly extended over the whole sample. The chromium plate remained firmly adherent and showed no tendency to lift or peel.

Cast Brass "1½"-Tees"

Number of Samples	*End of 1st Wk.*	*End of 2nd Wk.*	*End of 3rd Wk.*	*End of 4th Wk.*
1	O. K.	O. K.	O. K.	O. K.
2	O. K.	O. K.	O. K.	O. K.
3	O. K.	O. K.	O. K.	O. K.
4	O. K.	Tiny "spider-web" cracks in Cr plate. Plate very adherent.	Increase in cracks.	Increase in cracks. Plate still adherent.
5	O. K.	O. K.	O. K.	O. K.
6	O. K.	O. K.	O. K.	O. K.
7	O. K.	O. K.	O. K.	O. K.
8	O. K.	O. K.	O. K.	O. K.
9	O. K.	O. K.	O. K.	O. K.
10	O. K.	O. K.	O. K.	O. K.
11	O. K.	O. K.	Few pinpoint spots of brass showing through.	Many pinpoints of corrosion.
12	O. K.	O. K.	O. K.	O. K.

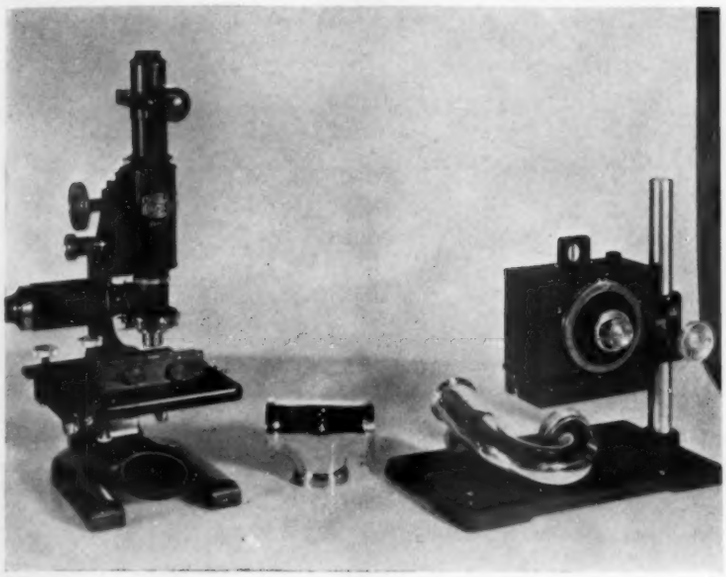

Fig. 2. Apparatus for determining thickness of plate. On left is microscope for determining copper thickness, and at right is the Magne-Gage for determining nickel thickness.

Tentative Conclusions Resulting from Outdoor Exposure

1. Confirmation of the value of nickel undercoating was further brought out as the first nickel undercoated sample did not show failure (pinpoint pits through to base metal) until after twenty-eight weeks—this was sample No. 3 of wrought brass.

2. The wrought brass samples without nickel coating made an extremely poor showing as the chromium began to flake off after four weeks exposure (these four weeks were very dry—no rain fell during this period).

3. The copper plated samples although first to show signs of failure (spider-web cracks) stood the test for adhesion and even after 15 weeks exposure, could be color-buffed up to almost their original finish with the cracks barely perceivable. However, by the end of the fifteen weeks there were a few pinpoints of corrosion which bared the base metal. These spots grew in size and number until at the end of 28 weeks, approximately 25% of the chromium (by area) was gone. Even then the remaining chromium was firmly adherent.

4. At the end of ten weeks exposure, the samples (wrought brass) plated only with chromium could be easily flaked off by rubbing with our hands. The base metal was copper colored and had the appearance of pure copper instead of the original light yellow of high brass. This absence of zinc on the surface was taken for an example of the common effect, "dezincification[2]," often noted in boiler tubes and marine piping.

5. The behavior of the cast brass samples differed somewhat in their reaction to outdoor exposure. All plated coatings remained firmly adherent even after 28 weeks of exposure. We found that previous work done on the problem of dezincification[2] brought out the fact that as the proportion of zinc decreases in the bass, the tendency to be subject to this action of "dezincing" decreases so this was set forth as a possible explanation of the better results found on the cast brass samples (Cast brass had 78-80% Cu). This theory also stood test when applied to the wrought brass samples with a copper undercoating. We therefore assumed that the copper plate prevented or retarded the action of dezincification.

6. Upon a careful examination of the wrought brass samples we found that failure in all cases began first at points which had been cold worked during the process of fabrication. These points would thus have a certain residual stress or strain left in the base metal. We checked the samples for stress by the "Mercuric Nitrate Test[3]," and found them to be strained at these points.

Further Work on Adhesion

We now had something definite to work on. The results of our cast brass tests showed that this type of alloy was best suited for plating of chromium direct—that it gave fair service even when compared to brass plated with a nickel undercoating. Now, we attempted to set up a line of reasoning which would derive some benefit from our findings on wrought brass. We considered these things collectively:

1. The copper plate greatly improved adhesion but the chromium coating cracked.
2. The chromium on direct plated samples flaked off first at points of base metal stress.
3. Cast samples showed no evidence of flaking and had no base metal stress.

We decided that there was evidence which led to the belief that base metal stress greatly affected the conditions which control the adherence of the chromium. At least things pointed enough in that direction that further tests should be made.

Samples were plated with 0.00002" of chromium over wrought high brass tubing which had been cold worked. Half the samples were annealed in our foundry core-oven for two hours at 450-500° F. The other half was untreated.

These samples were exposed on our roof under the same conditions as the prior tests. In nineteen days the unannealed parts began to show the same lines of cracks in chromium plate as had appeared on other wrought brass pieces.

It had been suggested that the cracking was in some way due to the final buffing operation, and that the cracks always ran at right angles to the direction of that buffing operation.

We carefully investigated this angle and found that it was not at all a consistent result. We did find that the cracks in the plate did always follow the lines of cold work operations such as drawing, swaging, flanging, etc., so that we felt it only a coincidence that the buffing was found at right angles to the cracks in several cases.

The annealed samples did not produce any cracks in chromium plate. These pieces have been observed over a period of eight months and, as yet, no cracks have appeared. There is the usual expected result of small pinpoint pits which expose the base metal.

Final Conclusions

1. Cast brass, of the higher copper

(*Concluded on page* 199)

Motion and Time Study In Electroplating

BY PHILIP J. LOPRESTI

BY THE use of motion and time study, a foreman plater can work more effectively. Before any steps are taken for expansion and increasing plating facilities, the plater should be satisfied that the present equipment is being used most effectively and that the plating process is efficient. With the use of a "flow process chart" the foreman plater will have a convincing statement to present management.

The "flow process chart" is a detailed study that includes:—

1. Total number of operations and time.
2. Total idle time of plating tank and plater.
3. Time required to get work.
4. Total distance travelled.
5. Total time required to do job.
   (a) Time to "Get Ready"—This is the time necessary to get racked or wired material ready for plating, or the cleaning time.
   (b) Time to "Do"—This is the actual plating time.
   (c) Time to "Clean Up"—This is the time necessary to dry and carry plated material back to unracking bench.

After a flow process chart is made of the present method the process is analyzed.

In the analysis, the operations are studied with a view to eliminate any that are unnecessary. The greatest savings can be made if the operation is eliminated. If no automatic equipment such as semi-automatic or full automatic plating tanks and conveyor systems are available, the layout of the plating unit is very important. The most efficient method would be one that has the cleaning, plating and drying equipment as close to each other as possible without congestion. The following figures and charts will show a case study of a plating unit. It shows a diagram of the present method of plating with a description of the operations in their sequence and the total plating time which consists of:

(a) "Get Ready"—Cleaning time
(b) "Do"—Plating time
(c) "Clean Up"—Drying time

With this information, the diagram of the proposed method is drawn and its flow process chart shows the operations, time and distance involved. In the summary of both present and proposed method, the efficiency of the proposed method is calculated and the percentage savings of time and distance travelled is calculated for the proposed method.

BRIGHT COPPER PLATING STEEL PARTS

Flow Process Chart of Present Method

Plater

No.	Operation	Time in min.	Dist. in ft.
1	Inspect work	15.0	
2	Start generator	5.0	
3	Wait	4.0	
4	Acid dip—2 racks	0.5	2
5	Rinse	0.5	4
6	Place in plating tank	0.5	4
7	Wait	2.5	
8	Acid dip—2 racks	0.5	2
9	Rinse	0.5	4
10	Place in plating tank	0.5	4
11	Wait	2.5	
12	Acid dip—2 racks	0.5	2
13	Rinse	0.5	2
14	Place in plating tank	0.5	4
15	Wait	2.5	
16	Acid dip—2 racks	0.5	2
17	Rinse	0.5	2
18	Place in plating tank	0.5	4
19	Remove 2 plated racks	1.0	4
20	Rinse	0.5	4
21	Hot rinse	0.5	4
22	Place in oven	0.5	8
23	Acid dip—2 racks	0.5	4
24	Rinse	0.5	2
25	Place in plating tank	0.5	4
26	Remove 2 racks	1.0	4
27	Rinse cold	0.5	4
28	Hot rinse	0.5	4
29	Place in oven	0.5	8
30	Acid dip—2 racks	0.5	4
31	Rinse	0.5	2
32	Place in plating tank	0.5	4
33	Remove 2 racks	1.0	4
34	Rinse cold	0.5	4
35	Hot rinse	0.5	4
36	Place in oven	0.5	8
37	Acid dip—2 racks	0.5	4
38	Rinse	0.5	2
39	Place in plating tank	0.5	4
40	Remove 2 racks	1.0	4
41	Rinse cold	0.5	4
42	Hot rinse	0.5	4
43	Place in oven	0.5	8
44	Acid dip—2 racks	0.5	4
45	Rinse	0.5	2
46	Place in plating tank	0.5	4
		53.5	146

Philip J. LoPresti

Plater's Helper

No.	Operation	Time in min.	Dist. in ft.
1	Clean rods	10.0	
2	Skim tank	5.0	
3	Get 2 racks work	0.5	
4	Take work to electrocleaner	1.0	40
5	Electroclean & brush	2.0	4
6	Rinse	0.5	4
7	Get 2 racks work	0.5	4
8	Take work to cleaner	1.0	40
9	Electroclean & brush	2.0	4
10	Rinse	0.5	4
11	Get 2 racks work	0.5	8
12	Take work to cleaner	1.0	40

13	Electroclean & brush	2.0	4
14	Rinse	0.5	4
15	Get 2 racks work	0.5	4
16	Take work to cleaner	1.0	40
17	Electroclean & brush	2.0	4
18	Rinse	0.5	4
19	Get 2 racks work	0.5	4
20	Take work to cleaner	1.0	40
21	Electroclean & brush	2.0	4
22	Rinse	0.5	4
23	Take racks from oven	0.5	
24	Take work to cleaner	1.0	40
25	Electroclean & brush	2.0	4
26	Rinse	0.5	4
27	Take racks from oven	0.5	
28	Take work to cleaner	1.0	40
29	Electroclean & brush	2.0	4
30	Rinse	0.5	4
31	Take rack from oven and get 2 racks work	0.5	4
32	Take work to cleaner	1.0	40
33	Electroclean & brush	2.0	4
34	Rinse	0.5	8
35	Get racks from oven and take, to unrack bench	1.5	
		48.5	412

Description of Present Process

Platers' Duties

1. Inspect work—"Get Ready"
2. "Do"—Plate
3. "Clean Up"—Day Work

Helpers' Duties

1. Clean tank—"Get Ready"
2. Clean work—"Get Ready"
3. Carry work to unrack bench—"Clean Up"

The plating cycle is 12 minutes. The plater places 2 racks in tank at one time until tank is full, which holds 8 racks. Then he removes 2 racks, replaces with 2 cleaned racks and keeps cycle going.

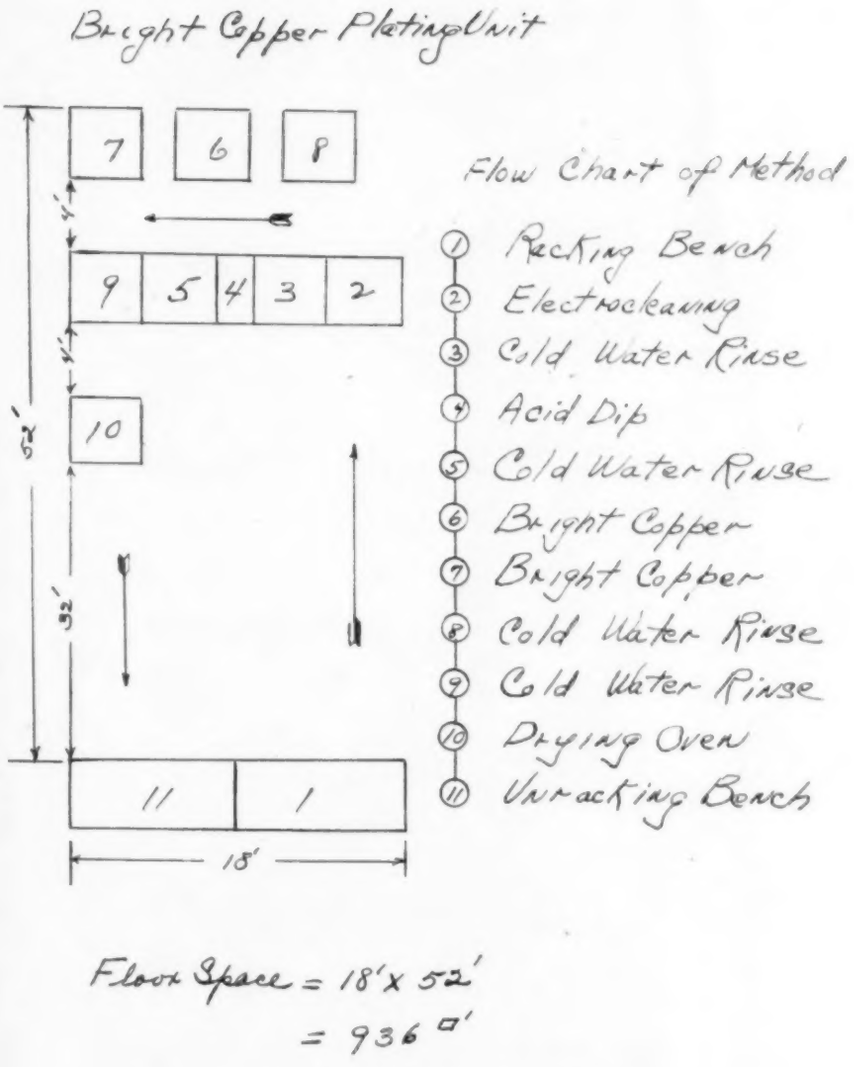

Fig. 1. Present method of bright copper plating.

BRIGHT COPPER PLATING STEEL PARTS

Flow Process Chart of Proposed Method

Plater

No.	Operation	Time in min.	Dist. in ft.
1	Get 2 racks	0.5	4
2	Take to cleaner	0.5	4
3	Electroclean	1.0	4
4	Rinse	0.5	4
5	Acid dip	0.5	2
6	Rinse	0.5	4
7	Place in tank	0.5	4
8	Acid dip	0.5	2
9	Rinse	0.5	4
10	Place in tank	0.5	4
11	Acid dip	0.5	2
12	Rinse	0.5	4
13	Place in tank	0.5	4
14	Wait	0.5	
15	Acid dip	0.5	2
16	Rinse	0.5	4
17	Place in tank	0.5	4
18	Wait	5.0	
19	Remove 2 racks	0.5	4
20	Rinse cold	0.5	4
21	Acid dip	0.5	2
22	Rinse	0.5	4
23	Place in tank	0.5	4
24	Remove 2 racks	0.5	4
25	Rinse cold	0.5	4
26	Acid dip	0.5	4
27	Rinse	0.5	4
28	Place in tank	0.5	4
29	Remove 2 racks	0.5	4
30	Rinse cold	0.5	4
31	Acid dip	0.5	4
32	Rinse	0.5	4
33	Place in tank	0.5	4
34	Remove 2 racks	0.5	4
		22	118

Plater's Helper

No.	Operation	Time in min.	Dist. in ft.
1	Get 2 racks	0.5	4
2	Take work to cleaner	0.5	4
3	Electroclean	1.0	4
4	Rinse	0.5	4
5	Get 2 racks	0.5	4
6	Take work to cleaner	0.5	4
7	Electroclean	1.0	4
8	Rinse	0.5	4
9	Get 2 racks	0.5	4
10	Take work to cleaner	0.5	4
11	Electroclean	1.0	4
12	Rinse	0.5	4
13	Get 2 racks	0.5	4
14	Take work to cleaner	0.5	4
15	Electroclean	1.0	4
16	Rinse	0.5	4
17	Rinse hot	0.5	4
18	Place in oven	0.5	4
19	Get 2 racks	0.5	4
20	Take work to cleaner	0.5	4
21	Electroclean	1.0	4
22	Rinse	0.5	4
23	Take racks from oven	0.5	4
24	Take racks to unrack bench	0.5	8
25	Get 2 racks work	0.5	4
26	Take to cleaner	0.5	4
27	Electroclean	1.0	4
28	Rinse	0.5	4
29	Rinse hot	0.5	4
30	Place in oven	0.5	4
31	Wait	4.0	
		22	124

Description of Proposed Method

In this method, the plater and plater's helper work together. Both start by cleaning 2 racks of work. The plater is responsible for the quality of the job and places the cleaned work in tank, removes 2 plated racks and replaces this space with 2 racks cleaned by his helper. The cycle continues and the tank is kept filled. The helper only cleans and dries work.

Plater

No.	*Operation*	*Description*
1	8	"Get Ready"
8	34	"Get Ready" and "Do"—plating time takes place while plater is getting work cleaned to put in tank. The plating time starts at 10 minutes and increases slightly.

Helper

1	17	"Get Ready"—Clean work
17	31	"Clean Up"—Dry work "Get Ready"—Clean work

Summary of Process Charts

Present Method

1. Work done—Plate 8 racks work, remove from tank and fill tank with 8 racks work.
   - (a) Total operations: 46 for plater; 35 for helper; Total operations 81
   - (b) Total distance travelled: 146 ft. for plater; 412 ft. for helper; Total distance 558 ft.
   - (c) Total time: 53.5 min. for plater; 48.5 min. for helper; Total time 102 min.

Proposed Method

1. Work done—Same as present method
   - (a) Total operations: 34 for plater; 31 for helper; Total operations 65
   - (b) Total distance travelled: 118 for plater; 124 for helper; Total distance 242
   - (c) Total time: 22 min. for plater; 22 min. for helper; Total time 44

2. Advantages of proposed method
   - (a) Percentage savings in operations
     $$\frac{81 - 65 \times 100}{81} = \frac{16 \times 100}{81} = 19.75\%$$
   - (b) Percentage savings in distance travelled
     $$\frac{558 - 242 \times 100}{558} = \frac{316 \times 100}{558} = 56.6\%$$
   - (c) Percentage savings in time
     $$\frac{102 - 44 \times 100}{102} = \frac{58 \times 100}{102} = 56.86\%$$

In the proposed method, the savings in operations, distance travelled and time saved will mean that the operator will be able to produce more work and earn more money. These savings are also made without any additional equipment but were made by using the present equipment more effectively.

Process Charts in Metal Finishing

1. *Flow Process Chart*

This process chart is for work that involves considerable walking, "Get Ready" and "Clean Up" such as drying plated parts. Processes well adopted for this chart are:—

- (a) Plating Methods
  - (1) Still plating
  - (2) Barrel plating
  - (3) Full automatic plating
- (b) Barrel tumbling and barrel burnishing

2. *Man and Machine Chart*

The man and machine chart shows the operations and names of the operator and the operations for the machine with the proper relationship to each other. This type of chart can be used on—:

- (a) Automatic buffing
  - (1) With this chart it is possible to list operations of operator, note his delays in feeding machine, and also note idle time of machine. This chart is valuable in finding the capacity of a machine and eliminating idle time due to operator or improper maintenance.
- (b) Automatic lacquering machines
- (c) Automatic plating machines

3. *Operator Chart*

The operator chart shows the left and right hand operations in their order of occurrence and their relationship to each other.

This type of chart could be used on metal finishing operations that require use of skill and the hands such as:—

1. Polishing, buffing, coloring
2. Lacquering

By the use of this type of chart on highly skilled work, it is possible to standardize the job and have a very efficient method of teaching new operations. If new operators are taught only the necessary right and left hand motions, the job is simplified and no artistic touch is needed. In the flow process chart, it was shown how a plating process could be improved by having the cleaning and drying units

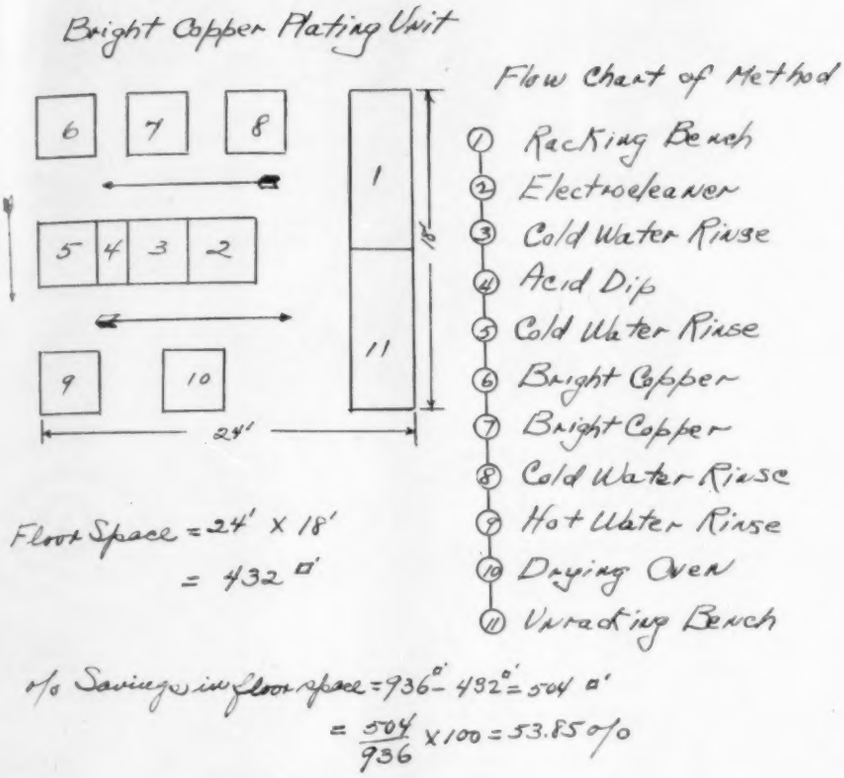

Fig. 2. Proposed method of bright copper plating.

close to the plating tank. With the operator chart, the process such as buffing or lacquering is more efficient if the work and lathe, or the work and spray gun are in the normal reach of the operator.

4. *Cost Process Chart*

The cost process chart shows the progressive record of any job. It contains information of any job. It contains information relative to the present and objective costs, the proposed method, and the persons responsible.

The purpose of this paper is to show what can be accomplished by motion study. Motion study improves the method without speeding up the worker. With motion study, unnecessary operations, moves and idle time are eliminated and only effective work is accomplished. By this method the worker may work as much, but he can produce more in the same time.

Reference: — "Motion & Time Study" by George W. Chane, Consulting Industrial Engineer, Ernst & Ernst, Boston, Mass.

content type, may be chromium plated without the benefit of a protective nickel undercoating with reasonable assurance of a presentable, lasting, decorative coating. (In terms of present day shortages.)

2. The annealing of high zinc wrought brass parts after chromium plating has a definite advantageous effect on the adhesion of the chromium plate. Perhaps the answer to this result lies in the field of electrochemistry, in that dezincification of the brasses containing both alpha and beta constituents (as our samples did) may be accelerated by the residual stresses in that brass. This is not an attempt to answer the problem, but only a thought that the results points in that direction.

References

1. "Outdoor Exposure Tests of Electroplated Nickel and Chromium Coatings on Steel and Non-Ferrous Metals"—A.E.S.—ASTM and National Bureau of Standards—p. 464.

2. "Corrosion Resistance of Metals and Alloys" McKay and Worthington, 1936, pp. 433-455.

3. "Season Cracking in Non-Ferrous Metals"—H. M. St. John, Industrial Heating—July 1941.

Chromium Plating of Brass

(*Concluded from page* 195)

Fig. 3. Test samples exposed to outdoor atmosphere.

Patents

Electroplating Contact Roll

U. S. Pat. 2,266,347. C. G. Watson, Dec. 16, 1941. An improved contact roll for electroplating machines, of novel design.

Electroplating Process

U. S. Pat. 2,266,330. J. S. Nachtman, Dec. 16, 1941. A method of coating strip steel with tin comprising electroplating first a thin deposit of copper, nickel, chromium, cobalt, tungsten and iron directly upon each side of the strip, then heating in a reducing atmosphere to a temperature not in excess of 1950° F. to provide an alloy layer and a layer of pure deposit, controlling the thickness of the alloy layer by controlling the heating temperature, then electro-tin plating between 0.000015" and 0.00018" on each side, then heating in a reducing atmosphere to a temperature at least as high as the melting point of the tin, whereby alloying to the strip is secured.

Nickel Dip for Enamelling

U. S. Pat. 2,265,467. H. W. Alexander & R. S. Sheldon, assignors to General Motors Corp., Dec. 9, 1941. A process for an immersion deposit of nickel on iron to be vitreous enamelled which comprises immersion in a solution from the group consisting of nickel sulfate, nickel chloride and nickel nitrate, and reducing the acidity of the solution by the addition of a compound selected from the group consisting of lithium hydroxide, sodium hydroxide and potassium hydroxide.

Example:

Single nickel salts	2-4 oz./gal.
Boric acid	¼ "
Alkali, as above to pH	5.2-6.4

Immerse the iron for about 5 min. at about 160 or 170° F. Rinse for 1½ min. in a solution of 0.1% by weight of sulfuric acid and then neutralize in the usual neutralizing bath. The patent claims the use of the above mentioned alkalies as an improvement over the use of ammonia for control of the pH.

Etching Stainless Steel

U. S. Pat. 2,266,430. I. C. Matthews & G. B. Hanneman, assignors to Eastman Kodak Co., Dec. 16, 1941. An etching solution for stainless steel comprising approximately 4 parts by volume of saturated ferric chloride solution, 1 part of volume concentrated nitric acid and 1 part by volume of a 50% aqueous solution of hydrofluoric acid. The last is the usual commercial hydrofluoric acid.

Hot Galvanizing

U. S. Pat. 2,273,427. R. J. Wean, H. E. Melin & E. R. Berk, assignors to The Wean Engineering Co., Inc., Feb. 17, 1942. A hot galvanizing machine for sheet material.

Hot Tinning Machine

U. S. Pat. 2,271,780. H. Sebell, assignor of one-half to A. H. Parker, Feb. 3, 1942. An apparatus for applying a coating of tin to sheet metal comprising an elongated roll partially submerged in a bath of molten tin, means to rotate the roll, and means to feed the sheet to be tinned longitudinally of the roll and in contact therewith.

Strip Processing Machine

U. S. Pat. 2,271,735-6. W. F. Hall, assignor to Hanson-Van Winkle-Munning Co., Feb., 3, 1942. A machine of novel design for electroprocessing long metal strips.

Treating Pickling Wastes

U. S. Pat. 2,271,524. L. F. Marek, assignor to Arthur D. Little, Inc., Feb. 3, 1942. A process for the treatment of spent pickling liquor which comprises maintaining a spent liquor containing sulfuric acid and ferrous sulfate at a temperature above about 150° F. and evaporating water therefrom, removing the precipitated ferrous sulfate, subjecting the said ferrous sulfate for a sufficient time in an oxygen containing gas and water vapor while maintaining it at a temperature between 750 and 950° F. to oxidize the major portion of the iron to the ferric state without appreciable loss of oxides of sulfur, subjecting the roast to ammonia in the presence of water to produce ammonium sulfate and separating same from the reaction mixture.

Hot Dipping

U. S. Pat. 2,271,094. H. W. Pleister, assignor to Diamond Expansion Bolt Co., Inc., Jan. 27, 1942. A continuous method of treating small parts immediately after hot dipping by feeding into the bottom of a centrifugal basket to spin off the excess coating metal and continuously discharging the centrifuged articles over the upper edge of the basket.

Pickling Machine

U. S. Pat. 2,270,892. S. N. Dover, assignor to Agnes J. Reeves Greer, Jan. 27, 1942. A pickling apparatus for pickling a coil of metal comprising a tank for the solution, a mandrel to support the coil and a rotating means.

Grinding & Polishing Machine

U. S. Pat. 2,269,197. A. E. Hamilton, Jan. 6, 1942. A grinding and polishing apparatus for strip material comprising a feeding means, polishing wheels and a means for imparting combined reciprocatory and vibratory movements to the wheels in directions generally transverse to the path of travel of the material.

Pickling Apparatus

U. S. Pat. 2,267,146. L. H. Wilson, assignor to Sharon Steel Corp., Dec. 23, 1941. A machine and process for electrolytically cleaning and pickling stainless steel and other metals continuously using longitudinally arranged, spaced stationary electrodes of opposite polarity.

Buffing Machine

U. S. Pat. 2,269,133. M. H. Stevens, Jan. 6, 1942. A buffing machine equipped with reciprocating tables.

Corrosion Prevention of Magnesium

U. S. Pat. 2,269,435. R. W. Buzzard, Jan. 13, 1942. A method of producing corrosion resisting coatings on magnesium and magnesium alloys comprising forming an adherent coating by subjection of the metal to the action of an aqueous solution containing sodium dichromate and nitric acid (Chrome Pickle) for a period of from ½ to 2 minutes and thereafter subjecting the coated metal to an aqueous solution containing approximately 10% sodium dichromate saturated with magnesium fluoride for a period of from 5 minutes to one hour, the temperature of the second solution being maintained between 80° C. and the boiling point of the solution. The pH should be 3 to 6.5.

Nickel Anodes

U. S. Pat. 2,274,056. G. F. Geiger, assignor to The International Nickel Co., Inc., Feb. 24, 1942. A process for producing extruded nickel anodes by casting ingots and extruding same about 900°—1,200° C. to form anodes substantially free from slag inclusion common to cast anodes and corroding as uniformly as rolled anodes.

Polishing Wheel

U. S. Pat. 2,274,185. H. R. Benbow, assignor to Divine Bros. Co., Feb. 24, 1942. A polishing wheel comprising two sets of exterior sections and therebetween a plurality of interior sections, all said sections being composed of several layers of polishing wheel material laid face to face, with sections fastened so that all the faces between adjacent sections are parallel plane surfaces at acute angles to the exterior surfaces of the wheel.

Coating Ferrous Metals

U. S. Pat. 2,274,671. K. Daeves, G. Becker and F. Steinberg, (Germany), Mar. 3, 1942. A method of forming chromium-containing layers on ferrous metal articles which comprises packing the articles in pieces of ceramic carrier material selected from the group consisting of porcelain and sillimanite charged with chromium chloride and admixed with pieces of ferro-chromium, and heating the mass to a temperature in the neighborhood of 900 to 1,100° C.

Electroforming

U. S. Pat. 2,275,582. A. W. Bull, assignor, by mesne assignments, to U. S. Rubber Co., Mar. 10, 1942. A method of making a tire mold which includes molding a matrix of vulcanized rubber to form a semi-toroid replica of a tire, positioning metallic inserts and electroforming a metal shell upon matrix and inserts, after which the shell with the inserts embedded therein is removed from the matrix.

PLATING AND FINISHING
POLISHING — BUFFING
CLEANING — PICKLING
HOT DIP FINISHES

SHOP PROBLEMS

Embrittlement of Plated Springs

Q. The writer is called upon regularly to electroplate springs, using nickel and chromium plates. Although I have had some success, a 100% job has been very difficult for me to do. I would appreciate any suggestions that you may care to make.

A. We are somewhat puzzled why nickel and chromium plate should be specified for springs because if corrosion protection is desired, a much thinner coating of zinc or cadmium will suffice to give the same protection. In addition, nickel and chromium are exceedingly scarce for general use at the present time, and it would be a point of wisdom to consider the use of zinc or cadmium plate.

The major difficulty in plating of springs is due to the nascent or atomic hydrogen evolved in the cleaning, pickling and plating processes. Both plain carbon steels and alloy steels are prone to hydrogen embrittlement. Regardless of the plating solution used, non-electrolytic cleaning should be done, and the acid dip employed for oxide or rust removal should be completely inhibited to prevent evolution of hydrogen. The plating solution should be operated at highest efficiency possible, which means solution control should be regular and the lower ranges of current density employed. The plating time should be kept to a minimum, and usually from 0.0001" to 0.0002" of zinc or cadmium are sufficient.

After plating, the springs should be given a heat treatment for from 1 to 3 hours at a temperature ranging from 350 to 500° F., to remove dissolved hydrogen. Failure to clean, plate and heat treat springs correctly would result in a serious source of incipient danger to the working part on which the spring is employed. Tests have indicated that a combination of nickel and chromium plating leaves much more serious hydrogen embrittlement than zinc or cadmium plating, and embrittlement in cadmium plating appears to be somewhat less than in zinc plating. Where mild atmospheres are to be withstood, it has been found that the chemical black finishes are very suitable for treating springs, inasmuch as the application of oxide films in the various proprietary black finishing processes is without any hydrogen evolution.

Foggy Spots from Cleaning

Q. We are having considerable difficulty in giving the enclosed sterling silver item (sample is unplated) a light nickel plate to prevent tarnishing. We have been washing them in a solution made of soap chips, then a rinse in cold water, then electrocleaning them (in a solution made of 2 oz. of trisodium phosphate, 2 oz. of sodium bicarbonate, ½ oz. sodium cyanide, 1 gal. water, at 200° F.; 6 volts. Items are hung from cathode bar and are electrocleaned for about 5 seconds, then cold rinsed and then put into the nickel solution. The difficulty is: when the items come out of the electrocleaning solution, they seem to have some sort of an invisible coating that plates over foggily in the nickel. This coating is shown by the fact that part of the buckle which is so coated comes out of the cold rinse after electrocleaning with very small bubbles on it, which look like water bubbles on an oily surface. And, if we dry them after this and before nickel plating, we get little foggy spots on the work wherever these bubbles appeared.

The longer we keep the work in the electrocleaning solution, the greater is the area covered by the small bubbles.

A. We believe that the chief reason for your difficulty is the presence of sodium cyanide in your electrocleaner. The electrocleaner is capable of dissolving various metals, such as copper, zinc and lead, especially when sodium cyanide is present. The fact that the trouble is worse when the electrocleaning is longer, indicates that you are progressively plating out metallic smut.

The writer has shown that metals such as copper, iron, lead and tin can be plated out of an electrocleaner, even when no sodium cyanide is contained in the cleaner. This metallic smut can cause peeling of the subsequent electroplate, can cause the plate to be rough and also pitted. We know of no simple method of purifying the solution and the usual method is to make up a new cleaning solution when it starts to plate out smut. Of course, cleaning anodically or without current will obviate the formation of smut.

We note your reference to the use of nickel plate, and we would like to point out that after April 1st you are no longer allowed to use nickel plate on the various articles made by you unless the work is to be done under a priority rating of A-1-k or better. —W. R. M.

Pickling Sterling Silver Buckles

Q. The writer would like to receive information on pickling Sterling silver buckles. I would like to remove a fire scale or fog that forms on the silver during treatment.

A. Fire scale on sterling silver can be removed in a solution of 3 parts nitric acid, 1 part of water, by volume. The work will turn gray in color. A few seconds is all the time required. For best results, operate solution hot, by having the crock surrounded by a hot water bath. Silver can be recovered from a spent dip by adding a chloride.

An alternative procedure to the use of the nitric acid dip is to heat the sterling article, after fabrication is complete, to a dull red. Then clean, and follow with a pickle in 8% sulfuric acid. The fire scale will then be uniform all over the article and it can be satin finished and burnished, or color buffed. The silver will not have as white a color or take as high a luster, but will have a good color.

Work made the anode in a solution of 8 oz. sodium cyanide, 4 oz. sodium ferrocyanide to a gallon of water, will be given a fair luster. The work must be cleaned first. Also keep it in agitation during the anodic treatment. Do not agitate solution by air or stirring.

Some work has recently been done on the electrolytic polishing of silver, and will soon be published by the Electrochemical Society.

Blackening Brass

Q. We have tried the copper carbonate-ammonia solution for blackening brass described on page 94 of your 1941 "Plating and Finishing Guidebook", and we have met with no success in obtaining a good black color. Will you please send me either a new solution or some suggestions for obtaining a black finish on brass.

A. The copper carbonate-ammonia solution is suitable for obtaining a blue-black color on brasses containing 25% zinc or more. The solution must be operated warm, and a bright dip should be used preceding the blackening treatment.

Until recently there was no satisfactory method of simple, direct low temperature blackening of copper alloys containing 25% zinc or less, as well as copper and copper-tin alloys. A method* has been advertised in METAL FINISHING for anodic blackening of copper. This involves making the work the anode in a proprietary solution, and a dull, velvet black finish is stated to be obtained. In the March issue of METAL FINISHING, there was announced a method* for direct low temperature chemical blackening of copper and almost all copper alloys.

In regard to the copper carbonate-ammonia process, we would like to point out that excellent results have been obtained using copper sulphate and ammonia, and the concentrations must be so selected that an excess of copper hydroxide remains in the solution. This is probably due to the fact that an excess of ammonia in the bath will re-dissolve the cupric oxide deposit formed, or will prevent its formation. If the ammonia content is too low, then the attack on the brass is retarded and no satisfactory deposit is obtained.

*Names furnished on request.

NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL INDUSTRY

Polishing and Buffing Compounds

The Roberts Rouge Co., Stratford, Conn., manufacturers of rouges and various buffing compounds, have announced that they have steadily added to the products manufactured by the company.

The firm is supplying tripoli in various grades, emery paste in all sized grains, and more recently they have added lime compounds to the list of their products. The company particularly wants to call attention to their new "Roberts Burring Compound" which was developed to meet a demand for a sturdy buffing compound for general use on steel and any other hard metal. It is claimed that by the use of this compound, burrs and rough surfaces left on various metals after machining operations, can be quickly and efficiently removed, thus eliminating hand filing and other slower methods of accomplishment.

Substitute for Lanolin

Lanolin for industrial purposes can in many cases be successfully replaced by "Sublan," a lanolin substitute recently introduced by the Glyco Products Co., Inc., 230 King Street, Brooklyn, N. Y.

Sublan is made from domestic raw materials and is freely available for civilian use. In appearance it closely resembles lanolin, being a light colored stiff paste. It has a melting point of 55° C. to 60° C., and a surface tack similar to that of lanolin. Sublan is insoluble in water, glycerin and most water-soluble liquids. It is partially soluble in alcohol and vegetable oils. It is soluble in toluol and mineral spirits in the cold, and soluble in mineral oil when heated. Mineral oil solutions form soft gels on cooling.

Because of its water insolubility, it is suggested as a seal in lines carrying water and water-soluble liquids. It is of interest for the dressing, finishing and softening of leather and similar products. It is also suggested as a protective coating for metals and as a grease and lubricant in most cases where lanolin is being used for industrial purposes.

Samples and further information can be obtained from the Glyco Products Co., Inc., Brooklyn, N. Y.

Cleaner for Aluminum and Magnesium

A new cleaner for aluminum and magnesium has been developed by the Hanson-Van Winkle-Munning Co., Matawan, N. J., manufacturers of electroplating equipment and supplies. This cleaner has been given the name "Matawan AL".

The cleaner is designed for cleaning aluminum in either sheets or castings. (It may be used for magnesium under the same conditions.) Used at a concentration of 4 oz. per gallon at 160° F., it does not produce any etch or weight loss on aluminum sheet or casting after two hours' immersion. Machined and polished magnesium shows no weight loss or etching in 15 minutes or more.

The cleaner at 4 oz. per gallon and 160° F., has cleaned a mixture of equal parts of kerosene and heavy oil, water-break free in 20 seconds. In a number of tests on production castings, the time required was from ½ minute to 4 minutes for thorough cleaning, depending upon the type of work and amount of shop grease present.

This cleaner used at 175° F. will etch the work slightly and slowly; thus, as the temperature is increased, the cleaning rate is increased, but at the expense of etching. It is not to be used as an electric cleaner—it is strictly a soak cleaner. To avoid etching, the temperature must be limited to 160° F. At 175° F. or higher, for faster cleaning, some etching will take place.

Matawan AL is specially suitable for aircraft parts. Tests and demonstrations will be cheerfully given by the manufacturer.

New Sandblast Hose

The B. F. Goodrich Company, Akron, Ohio, have announced a new sandblast hose designated as "B.F.G." Because of its success in this service the company's previous "Anti-Static" sandblast hose which used an internal wire construction for dissipating static charges has been discontinued. There is no wire used in the new "B.F.G." sandblast hose. The rubber compound used carries away the static electricity as fast as it forms.

Laboratory tests made on conventional sandblast hose of excellent make and quality showed that the rubber compounds used in them had a resistance exceeding one quadrillion ohms per centimeter cube, while the resistance of the compound used in the new B.F. Goodrich hose is only 3000 ohms per centimeter cube. For the high voltages of static electricity the compound is practically as good a conductor as metal, the company's engineers point out.

Following laboratory tests on the new hose, several thousand feet were placed on test carrying high velocity sand on a large construction job in the far west, where the ordinary highest quality sandblast hose was not able to carry away the electricity and the hose could not be handled by the operator. The new hose performed its task so well under difficult conditions that thousands of feet of it were ordered. It not only carries away the high static charges, but is proving abrasion resistant to the sharp sand particles.

The new hose is made in four ply construction, with ¼ inch tube, in sizes ranging from ¾ inch to three inches.

Wetting and Emulsifying Agent

A wetting and emulsifying agent, "Dresinate," for use in conjunction with all types of alkaline metal cleaners has been developed by the Research Department of Hercules Powder Company, Wilmington, Del.

The penetrant, a finely divided, uniform powder, is available in practically unlimited quantities at a lower cost than the common emulsifying agents used by the metal cleaning industry, the company's announcement says.

The new cleaning aid is suggested for use in conjunction with trisodium phosphate, sodium metasilicate, caustic soda, soda ash, borax, and other alkaline detergents. Its use is indicated for cleaning metal prior to rust-proofing, lacquering, painting, or plating.

Professional Directory

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Complete services, including solution analyses, process development and deposit tests.
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Research work carried on at the Hercules Experiment Station indicates the material is suitable for all metal cleaning operations where an alkali cleaner is used to remove grease, oils, soil and organic materials.

"Addition of 3 to 15% 'Dresinate' to an alkaline cleaning solution, while it reduces the alkalinity slightly, nevertheless increases the detergency of the solution," the company says.

"The wetting action of 'Dresinate' puts a thin film of alkaline liquid uniformly over the metal surface, wetting out oily areas equally as well as areas free from oil. The emulsifying action assists the alkaline cleaner to get the foreign material in suspension and carry it away.

"The material can be mixed with alkaline cleaners without special equipment since it is a dry powder, readily and completely soluble in water. Alkaline solutions containing the material are rapidly rinsed from metals, speeding the time required for the cleaning operation."

Something New in the Care of Commutators and Rings

BY L. A. LEONARD

Vice-President, Ohio Carbon Co., Cleveland, Ohio

THE modern electric motor likewise the generator is more than a medium for transforming electric energy into mechanical power. It has developed into a highly refined tool to meet the exacting requirements of modern industry. Our present situation demands continuous efficient operation without costly shutdowns, without the use of priority materials if we are to wage this war to a successful conclusion. It's imperative that we get more motor mileage. You cannot operate today's motor with yesterday's methods and stay in business tomorrow.

By reason of our intimate association with commutating equipment as carbon brush manufacturers, we have long been cognizant of the need for a material or device which would do a satisfactory job of cleaning commutators or rings with a minimum of effort. In the past many methods have been tried such as powders, liquids, and solids of all kinds, but each though effective to a degree, was found wanting.

Wherever motors and generators are operating, the care of commutators and rings has always been a source of concern among those charged with the maintenance of such equipment. Such factors as location, humidity, temperature, abrasive and magnetic dusts, explosive and corrosive fumes, splashing liquids, and a variety of similar hazards affect commutation. Often the wrong brush grade selection will deposit film on the commutator. Good commutation is good performance under all conditions without injury to the equipment.

The preservation of the proper relation between brushes which ride a commutator and the revolving commutator itself is very definitely governed by the condition of the

METSO CLEANING *Passes* RIGID INSPECTION

Cadmium Plated Flasher Shells

Do you clean electrolytically, in soaker tanks or by barrel or spray washers? Depend on Metso for thorough, reliable cleaning for all metal cleaning.

Metso Cleaners speed up wetting and grease and oil removal. Dirt thus removed is prevented from redepositing onto cleaned surfaces through the unique properties of Metso's silica (SiO_2) content.

If you're working with soft metals such as zinc, tin or aluminum, the silica content protects them against chemical attack.

METSO CLEANERS—a family of silicate of soda cleaners for metal finishing

PHILADELPHIA QUARTZ COMPANY

EST. 1831

General Offices: 125 S. Third St., Phila., Pa. Chicago Sales Office: 205 W. Wacker Drive. Stocks in 60 cities. Sold in Canada by National Silicates Ltd., Toronto.

METSO CLEANERS

NEW DIRECT CURRENT PANEL BOARDS

Consisting of one DC 0/15 Volt VOLTMETER and one DC AMMETER with Shunt and Leads mounted on 10" x 6" x ½" thick Ebony Asbestos Panel Stock. Prices:

0/100	Amp. range	$15.00
0/200	" "	17.50
0/300	" "	20.00
0/500	" "	25.00
0/750	" "	27.50
0/1000	" "	30.00
0/1500	" "	37.50

Prices F.O.B. Cambridge, Mass.

These panel boards are excellent for Plating Barrels and Plating Tanks.

Guaranteed.

M. E. BAKER COMPANY

143 Sidney Street Cambridge, Mass.

The FINISH that will add instant sales appeal to *your* product.

EBONOL

REG. UNITED STATES PATENT OFFICE

THE JET BLACK CORROSION RESISTANT FINISH FOR IRON AND STEEL

Leading manufacturers of appliances, bicycles, coffee makers, radios, guns, bearings, buckles, buttons, tools and hardware, are using EBONOL to beautify their products and replace zinc, cadmium, nickel and other finishes.

Plants now doing plating need only ONE new tank to start using EBONOL.

Some proven advantages of EBONOL:

Fast Blackening by Immersion in Only ONE Bath
Deep Penetration—No Red Stains
Highest Corrosion Resistance
Simple and Economical to Operate

Send sample parts to be EBON-ized and let our finishing engineers serve you.

THE Enthone COMPANY

NEW HAVEN CONNECTICUT

commutator face. It naturally follows that such important factors as input and output are materially affected.

It was with these things in mind that our engineers went to work. This research naturally started in our laboratory and was extended to practical proving in the field. Testing under actual operating conditions provides factual information for development which could never be exposed in a laboratory. As a result, industry is offered something to maintain good performance without shutting down or dismantling motors or generators. Made of non-conductive materials, this tool can be safely used while the machine is in operation. It consists of a wooden handle and burnishing material. Styles for all sizes of commutators and rings ranging from fractional horse power to multiple horse power are available. It is comparatively as simple to use as an eraser.

This unusual material gives that final touch to a commutator surface electrical engineers have been seeking since the advent of commutating equipment. It is the most economical, effective, and efficient tool introduced to the electrical industry in years. It will hone the commutator to a degree impossible with the finest type of cutting tool. Then will keep it that way with periodical application at the discretion of the operator. We'll be glad to furnish the names of many nationally known users who have ordered and reordered these burnishers.

The treatment is simple, merely hold the burnisher firmly against the commutator until the film or glaze is removed. There is no dusting, neither will the slots fill up. Due to its resilient qualities, it will in many cases pull out material already deposited in slots. To accomplish this, apply a little more pressure. This burnisher must not be confused with a commutator stone. There is no cutting action. It will not reduce high mica, flat or burned spots. The burnisher polished to a perfect face removing only the surface film. Occasionally a slight trace of copper is picked up but this is negligible. If this occurs merely brush off with a cloth and continue. See the comparison, observe a commutator with a magnifying glass after it has been finished with a fine, cutting tool, and then after burnishing with this new material. That fuzzy shredded tex-

PERMAG Cleaning Compounds

More than 20 years aiding manufacturers in their metal cleaning problems — and now ready with Special Cleaning Compounds for the metal cleaning needs of manufacturers engaged in Defense and War work.

PERMAG is used for cleaning metals in the air craft industry.
PERMAG cleans brass, steel, aluminum and aluminum alloys.
PERMAG is fast—thorough—economical. Let us send details.

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ture gives way to a glass-smooth polished surface.

Brush operation is improved, with a clean, smooth commutator. Brushes perform better with less noise, contact drop is more uniformly distributed, and sparking is reduced. With intimate contact as a result of removing the high resistance film, you can expect better commutation, thereby reducing uneven brush wear and brush failures. Obviously, the efficiency of your machine is stepped up.

American Pumice Available

Whittaker, Clark & Daniels, Inc., 260 W. Broadway, New York City, have announced the sale of American pumice mined at Grants, New Mexico.

This deposit is stated to be relatively inexhaustible and is a true pumice stone and not volcanic ash. Chemical and physical tests have indicated, according to the company, that the Grants pumice is equal in every respect to the unobtainable Italian pumice.

The following chemical analyses substantiate this claim:

	American Pulverized Per Cent	*Italian Select Per Cent*
Silica	72.90	73.24
Alumina	11.28	10.61
Iron Oxide	.86	1.57
Titanium Oxide	.06	.10
Calcium Oxide	.80	1.10
Magnesium Oxide	.36	.40
Soda	3.64	3.03
Potash	4.38	5.58
Sulfuric Anhydride	.03	.05
Loss on ignition	5.20	4.04

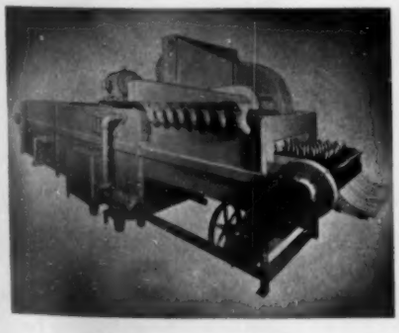
The company's method of processing the pumice is claimed to give consistent and uniform quality, and different mesh sizes are available for the various metal finishing processes.

Shell Cleaning Machine

The Alvey-Ferguson Co., 777 E. Disney St., Cincinnati, Ohio, have developed a new type washing machine to remove grease and chips as well as to dry 20 mm., 37 mm. and 40 mm. shells.

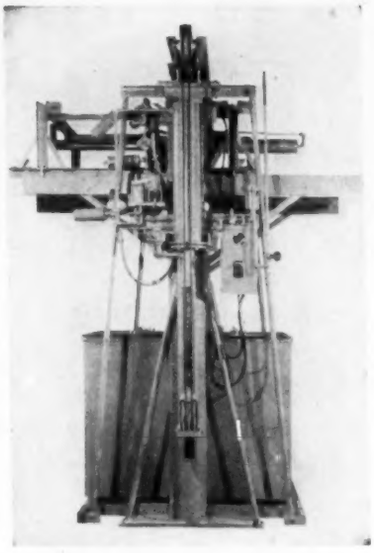
This machine was designed to replace the slower, more costly method of immersing shells in tanks of boiling solution by means of racks and hoists.

A feature of the machine is the automatic



Shell cleaning machine

Crown Pick-up Unit



...MACHINE...

A UNIT TYPE TRANSFER CAPABLE OF HANDLING SEVERAL TANKS AT ONE TIME.

●

...USE...

FOR A SERIES OF OPERATIONS WHERE THE WORK MUST PASS THROUGH SEVERAL TANKS, AS THE CLEANING AND RINSING OPERATIONS, FOR A SEMI-AUTOMATIC PLATING TANK.

CROWN RHEOSTAT & SUPPLY CO.
1910 MAYPOLE AVENUE :-: :-: CHICAGO, ILLINOIS

DEFENSE FINISHING PROBLEMS

Our complete line of polishing and buffing compositions including greaseless compound and a laboratory with a technical staff experienced in the problems encountered in finishing defense materials, are at your service.

Upon request we will be pleased to submit samples or have a salesman call.

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ROCHESTER MICHIGAN

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CHROMIC ACID

99.75% PURE

With two complete, independent plants at Jersey City and Baltimore, and its own supply of the basic raw material Chrome Ore from company owned and operated mines. Mutual is the world's foremost manufacturer of Chromic Acid.

BICHROMATE OF SODA
BICHROMATE OF POTASH

Mutual Chemical Co of America
270 MADISON AVENUE, NEW YORK

ejection of the shells. This new type machine, as well as other machines for washing, rinsing and drying of shells, shell fuses, cartridges, bombs, machine gun barrels and other war production parts are described in a new folder entitled, "Yes! All Metal War Products Must Be Cleaned." Interested executives may secure a copy of this folder by writing on their company letterhead to the above address.

High Tensile Strength Solder

A special solder developed for the soldering of all hard-to-solder metals such as aluminum, aluminum alloys, die cast, Dowmetal, Alnico, etc., has been perfected by the Lloyd S. Johnson Company 2241 Indiana Avenue, Chicago, Illinois. The material is claimed to be exceptionally free-flowing and provides unusual tensile strength in sheet metals and extruded aluminum. It retains color of aluminum and Dowmetal, and is corrosion resistant. Solder comes conveniently rolled ⅛" square and runs approximately 270 inches to the pound.

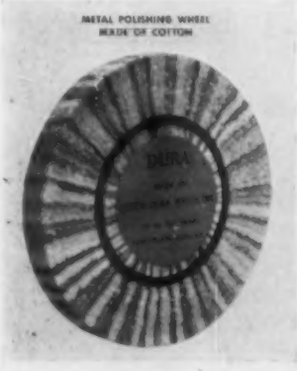
Wet Abrasive Belt Surfacer

A new "'600' Dri-N-Wet Abrasive Belt Surfacer" has just been placed on the market by Hammond Machinery Builders, Inc., 1601 Douglas Avenue, Kalamazoo, Michigan.

The machine can be adjusted from vertical to horizontal position while it is running. The belt tension and tracking device can likewise be adjusted while running, and is quickly accomplished by two conveniently located handles. The machine is totally enclosed for safety and the "600" Dri machine is arranged for an individual dust collector or for connection to an exhaust system. The abrasive belt pulleys are made of cast iron and are dynamically balanced. They run on dust-proof ball bearings and are properly lubricated. The work table can be adjusted to any desired working angle and is available as bench or floor model.

The Hammond "600" Dri-N-Wet machine (floor model illustrated) has all the outstanding features of the Hammond "600"

Wet abrasive belt surfacer



GRINDING AND POLISHING WHEELS

Leather — Canvas — Cotton
Wool

Efficient
Low Cost
Immediate Deliveries

ARROW DURA WHEEL, INC.

29-26 — 40 Rd., Long Island City

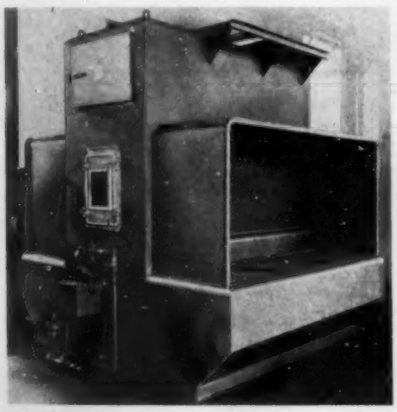
Dri plus providing wet operation for grinding, polishing or surfacing. It is equipped with tank and pump unit and can also be equipped for water main connection only. Also furnished in bench model with water main connection only. Both are equipped with damper or spray control and two nozzles for uniform spraying. Should dry operation be desired at any time on either machine, it is necessary to merely turn off the water, remove drain connection and attach air exhaust system at this point. Adjustable from vertical to horizontal position while running. Vacuum cup drive pulleys eliminating belt slippage furnished on wet machines only.

Wet operation has many important advantages permitting faster cutting at lower costs and prevents discoloration, fracturing, chipping, warping, and elimination of dust and fire hazards.

Samples are requested for production estimates without any obligation.

Dust Collector for Magnesium Alloy Dust

In burring and grinding operations on magnesium alloys, the danger from fire is an ever present menace unless suitable precautions are taken for its prevention. The dust and chips from magnesium alloys are highly inflammable and should be wetted as quickly as possible after being formed. All such grinding work should be done on a



Dust collector for magnesium alloy dust

FASTER, Better Cleaning at less than ¼ the Cost of Solvent Degreasing

HERE'S A HANDBOOK YOU NEED!

An up-to-date manual on methods of metal cleaning applicable to today's needs for fast, thorough and dependable results. Write NOW for your copy.

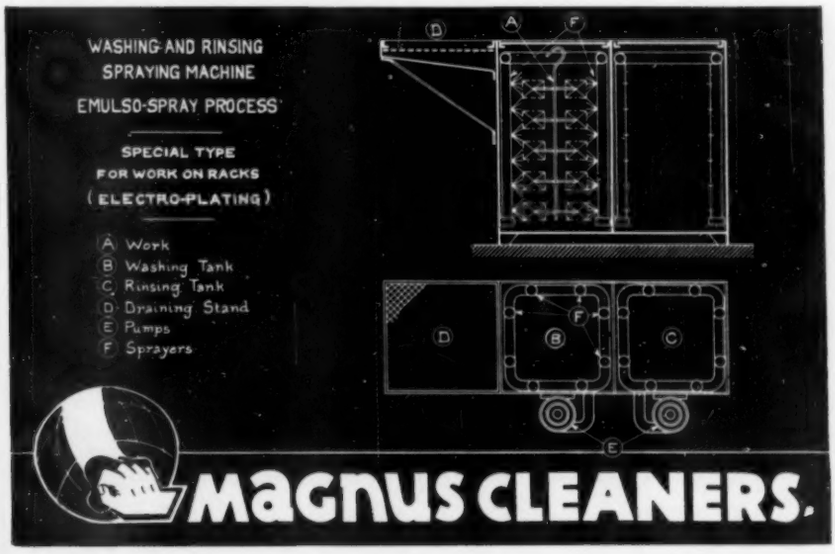
Even if supplies of degreasing solvents were plentiful, there's a faster, better way of cleaning metals in war time. It's a method that cleans more thoroughly and is more dependable, particularly on mixed dirts. It involves no noxious or toxic vapors. And the materials used are freely available.

MAGNUS
EMULSO-DIP and EMULSO-SPRAY

are two variations of the same cleaning method, applicable to both hand operated and fully automatic cleaning equipment. Either process is applicable to any metal and any dirt, particularly smut. Experience of users during the past year indicates that the cost of cleaning by this method is well under ¼ the cost of solvent degreasing.

It will pay you to investigate NOW. The method is often adaptable to existing washing machines, but if not, we will design Magnus Emulso-Dip or Emulso-Spray washing machines to meet your particular cleaning operations.

MAGNUS CHEMICAL CO., 11 South Ave., Garwood, N. J.



METAL COLORING AND FINISHING

Hugo Krause

Consulting Chemist to Metal Finishing Industry

$5.00

TELLS HOW . . .

—To color all types of metals and alloys
—To prepare metal surfaces for coloring
—To finish colored metals

It is comprehensive and will be of use as a reference and guide book to those engaged in metal coloring in its decorative as well as protective phases. Many of the so-called secret process of the electroplating art are described in considerable detail with critical comments by the author.

WHAT THIS BOOK CONTAINS

Formulae and Patents
Influence of Alloying on Coloring
Difficulties Encountered
Preparation of Surfaces
Degreasing
Rust Removal
Grinding
Polishing
Cleaning
Lacquering
Waxing
Electrochemical Methods
Dipping
Rubbing and Contacting Methods
Nickel
Copper Gold
Silver Zinc
Brass Bronze
Cadmium Tin
German Silver
Aluminum
Magnesium
Varnishes
Metal Lacquers
Bronze Powders
Antiquing Imitation
Platinum Finish
Coloring and Protecting Iron
Brass Zinc
Tin Silver
Gold
Platinum Plating
Precipitating Antimony
Arsenic and Bismuth
Bibliography
Cathode Treatments
Anodic Metal Coloring
Protective Coats
Green Plating
Chemical Metal Coloring
Tempering
Burnishing
Phosphatizing Rust Prevention

Metal Finishing, 116 John St., New York

Book Payable In Advance

bench which is properly hooded and ventilated for the protection of the operator.

The Mahon Hydro-Foam Dust Collector—developed to collect, under water, various dusts formed by industrial processes—is claimed to be ideally adapted to the collection of dust and chips formed in the burring and grinding of magnesium alloy castings.

For this kind of work a special Hydro-Foam Dust Collector has been designed. It is a completely self contained unit, providing in one machine both bench and hood, together with adequate dust collection and ventilation.

The tank, forming the base of the unit, is filled with water, kept at a constant level, and supplied with water service to make up the small evaporation losses. The side extension of this tank forms the bench which has for its surface a wooden grillage. The hood formed above the grillage confines the operations and the dust therefrom is drawn through this grillage onto the surface of the water, directly underneath.

In this first stage of dust elimination, the larger chips and coarser dust particles settle by gravity to the bottom of the tank. The air, still carrying a considerable volume of dust, is then forced downward at high velocity against the water solution in the tank. This second elimination stage forces the bulk of the remaining dust into the water. The impinging action of this operation aerates the water solution and creates a bed of spray in the chamber above the water tank. Only the finest dust particles remain in the air currents passing up and through this spray, where they are wetted and retained in this third and final stage of dust removal. The exhaust fan and motor are mounted on the top of the unit and discharge directly into the room through a diffuser head, unless it is desired that this exhausted air be discharged outside the building.

If the exhausted air is discharged inside, there is no loss of heat in the building and the evaporation in the unit slightly raises the humidity of the room in which the unit is located.

The only moving part in this unit is the motor driven fan, making for simplicity of operation. There are no pipes, pumps or nozzles in the air stream. One starter only is necessary. Each unit should have a water supply line for filling the tanks and replenishing the evaporation losses and a drain connection to the sewer for periodic cleaning. All dust and chips are collected into the water in the tank, settling to the bottom. Here they remain in an undisturbed condition until the tank is drawn and the material is removed for reclaiming or disposal.

Large dust collecting systems, having ventilated benches and extensive systems of exhaust piping for conveying the dust to a collector in a remote location are not recommended as the dust in these ducts causes a serious fire hazard between its point of origin and its collection.

These machines are made in single or double units, as shown in the accompanying illustration. Thus, operators may work on one side or both sides, depending on local requirements. The entire unit is portable and only requires electrical, water and drain connections. Complete information regarding this improved dust collecting machine may be had by writing The R. C. Mahon Company, Detroit, Mich., whose engineers are responsible for its development and manufacture.

BLACK-MAGIC

The blacking process which goes farthest

—in Color —in Rust Prevention —in Penetration

and does it in *One Bath*

Saves 60% over dual bath processes

BLACK-MAGIC

is *government approved* and there are
no government restrictions on its use. (immediate shipment)
Costs only a fraction of the plating materials it supplants.

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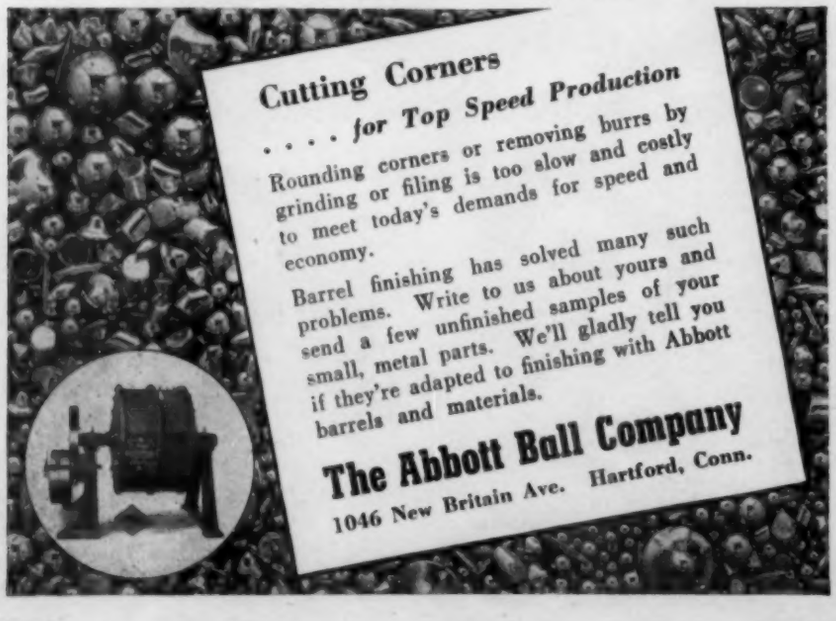
HENRY STEINHAUS & CO.
617 North Second St., Milwaukee, Wis.

Baths for cast iron, brass, copper-zinc and antimony.


Cutting Corners
. . . . for Top Speed Production
Rounding corners or removing burrs by grinding or filing is too slow and costly to meet today's demands for speed and economy.
Barrel finishing has solved many such problems. Write to us about yours and send a few unfinished samples of your small, metal parts. We'll gladly tell you if they're adapted to finishing with Abbott barrels and materials.
The Abbott Ball Company
1046 New Britain Ave. Hartford, Conn.

Manufacturers' Literature

Acid Proof Pipe and Fittings

Bulletin No. 550 entitled "Acid-Proof Pipe and Fittings" of the *U. S. Stoneware Co.*, 60 E. 42nd St., New York, has just been published. This 12-page bulletin gives specifications and other descriptive information on various pipes, fittings, traps and sumps to be used where corrosion resistance to acids, alkalies, solvents and other agents, is required.

"Electric Gaging"

Booklet GES-2543, recently issued by the *General Electric Company*, Schenectady, N. Y., tells in interesting, concise fashion of eleven outstanding instances where savings in both time and money, and at the same time improved quality, have resulted from the application of extremely sensitive yet sturdy electric gaging equipment.

The booklet illustrates such electric gages as the strain gage, pressure gage, film-thickness gage, eccentricity gage, profile gage, electrolimit gages, and the tensiometer. Applications for each are also suggested.

Flux Chart

Krembs & Co., 669 W. Ohio St., Chicago, Ill., have issued a new chart to enable the ready selection of the most suitable flux for metal joining operations, such as welding, brazing and soldering. This chart is claimed to be based upon the company's 75 years of experience in metal joining problems, and contains answers to over 400 questions pertaining to fluxing.

Lead and Tin Products

Alpha Metal & Rolling Mills, Inc., 363 Hudson Ave., Brooklyn, N. Y., have recently published a 4-page folder describing various lead and tin products made by the company. These include solder of various forms, anodes of lead, antimonial-lead, and tin-lead for chromium plating and other purposes; sheet, strip and extruded shapes of various sizes, as well as wire, rod, pipe and tubing. Various physical data on lead-tin alloys are also given, including melting points of various mixtures, specific gravity and weight per unit of volume.

Metal Substitution Chart

Apollo Metal Works, 66th Place & S. Oak Park Ave., Chicago, Ill., have just issued a folder giving charts to enable the selection of substitute metals to replace critical metals. The company's substitute metals are electroplated steels, and thus it is suggested that nickel plated steel be used as a substitute for stainless steel, copper plated steel to be used as a substitute for copper, and likewise, for brass plated steel.

The amount of metal saved by this process is shown graphically, and technical data on thickness of plate are given.

Pre-Finished Metals

American Nickeloid Co., Peru, Ill., have recently put out calendar type literature containing samples and information on the company's preplated metals. Samples illustrated include chromium plated steel, both bright and matte, brass and copper plated steel, chromium plated brass and nickel plated steel. The use of preplated stock in place of solid non-ferrous metals is important because of the need to conserve the non-ferrous metals, and thus for example, the use of copper plated steel in place of copper sheet of the same thickness saves up to 98% of the copper normally required. The conservations involved in the use of plated materials are graphically shown.

Preparing Aluminum for Anodizing

MacDermid, Inc., Waterbury, Conn., have published a technical data sheet entitled, "Preparation of Aluminum for Anodizing". This data sheet describes the company's materials recommended for treating aluminum previous to the anodizing process. Products described are: immersion type materials for pre-cleaning, alkali cleaners for final cleaning previous to anodizing, and stripping cleaners for removing anodic films without attack on the base aluminum.

Technical information on the cleaning process and features of the cleaners are given.

Technical Publications

Steel Products Manual. Flat Steel Wire, Section 17. American Iron and Steel Institute, 350 Fifth Ave., New York, N. Y. February, 1942. Price 25c each, post-paid.

Revere Weights and Data for Copper, Brass and Bronze Products. Fourth Edition. Published by Revere Copper and Brass, Inc., 230 Park Ave., New York.

A *CLEAN* HIT WITH A *CLEAN* BOMB!

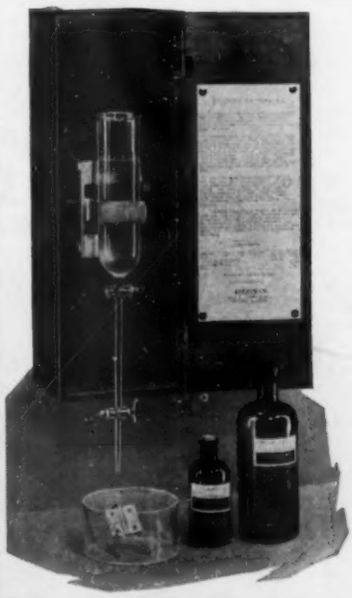
EVEN bombs for the dirty business of war are thoroughly cleaned before painting and lacquering.

Speeding manufacturers of war materials are turning more and more to Wyandotte Metal Cleaners for cleaning bomb bodies . . . cartridge cases . . . steel projectiles . . . bomb fins . . . fuses . . . pistons . . . crankshafts . . . and myriads of other war metal-cleaning jobs.

There is a Wyandotte Cleaner for *any* metal-cleaning problem and for use in *all* types of equipment.

Wyandotte PRODUCTS
SERVICE REPRESENTATIVES IN 88 CITIES

THE J. B. FORD SALES COMPANY, WYANDOTTE, MICHIGAN



CONTROL
SOLUTIONS
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DEPOSITS

METAL IS TOO DIFFICULT TO OBTAIN TO WASTE IT

Thickness Test Sets to conform with Army—Navy Specification AN-QQ-P-421a for Cadmium and Zinc.

A complete line of Testing Sets for controlling solutions and testing deposits.

Complete laboratory service.

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STEP UP PRODUCTION
CUT DOWN REJECTS

Fill in the coupon below—it will bring you complete information.

THE COWLES DETERGENT CO.
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The Cowles Detergent Company, *Metal Cleaner Department*
7016 Euclid Ave., Cleveland, Ohio

*What do you recommend for this type of cleaning?*_____

Company _____

Street and No. _____

City and State _____

Signed _____

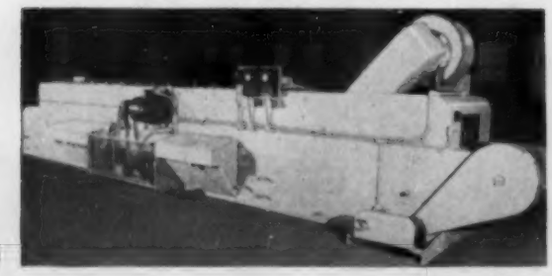
Title or Department

RANSOHOFF *Equipment helps to* KEEP 'EM FLYING

Designed for and installed in one of the foremost aircraft plants, is this Ransohoff Wash, Rinse and Drying Equipment. Here, airplane motor valves are washed, rinsed and dried in one machine—automatically.

Not only is it doing a better job, but it saves valuable man hours, increases production, and reduces costs. A typical example of how Ransohoff Equipment is playing its part in the Victory Program.

You, too, regardless of what you make, can streamline your washing, rinsing and drying of metal parts, for final finishing, by installing Ransohoff Equipment.



Settle your cleaning problems, today. Use Ransohoff Equipment to meet your specific needs.

Write or wire Dept. "MF" for further information.

N. RANSOHOFF, Inc.
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CINCINNATI, OHIO

A valuable booklet giving data on Revere copper alloys, including that for sheet, rod, pipe and tubes. Miscellaneous data given in the beginning of the book should be particularly valuable to metallurgists and engineers. These include comparisons of various wire gauges, melting points of metals, conversion tables, areas of circles, squares, weights per sq. ft. of various sheet alloys are given, and weights per lineal foot for bars and tubes are included.

Proceedings Sixth Annual Forum Porcelain Enamel Institute

Copies of this publication are available from the Porcelain Enamel Institute, 612 North Michigan Avenue, Chicago, Illinois, and are priced at $2.00 each. A complete set of the proceedings of the six Forums to date is available at a cost of $5.00.

The American Coordinating Committee on Corrosion is contemplating revision of its confidential Directory of technologists actively engaged in studies on corrosion and its prevention. The Committee comprises delegates from the seventeen major technical societies together with representatives from the principal industrial research institutes and the National Bureau of Standards. Its Directory currently lists some 400 investigators in a diversity of corrosion-preventive fields, selected on the basis of questionnaires circulated to the membership of the Committee's member societies. While it is felt that the Directory list is quite complete, there are undoubtedly some individuals who were not reached during the original circularization. Accordingly, the Committee now requests that all persons actively engaged in corrosion researches who have not been contacted by the Committee, write to the Secretary, *Dr. G. H. Young*, 4400 Fifth Avenue, Pittsburgh, Pa. For further details and application forms for Directory listing.

Obituary

Lloyd B. Edgerton

Lloyd B. Edgerton, Vice President of the Philadelphia Quartz Company, Philadelphia, Pa., died March 15 at the Presbyterian Hospital, that city, after a long illness. He was fifty-five years of age. Born in Barnesville, Ohio, Mr. Edgerton graduated from Ohio State University, Class of 1909. After obtaining his degree of Mechanical Engineer, he was associated with General Electric Company at Schenectady, N. Y. in their Steam Turbine Testing and Service Department. In 1913, he entered the employ of the Philadelphia Quartz Company, assuming charge of the Engineering Department. He was appointed Works Manager in 1930, Director in 1934 and Vice President in 1935. He was a member of the American Society of Mechanical Engi-

neers and the Engineers' Club of Philadelphia.

Mr. Edgerton is survived by his wife, Hazel M., two sons, B. Dale Edgerton of Trenton, N. J. and Donald, a student at the University of Virginia and a daughter, Mrs. Robert T. Gladstone, Jr. of Norfolk, Va.

Associations and Societies

American Electroplaters' Society

Annual Convention

June 8-10 Grand Rapids, Mich.

Tentative Technical Program

Monday Morning, June 8.

Special Defense Session

1. "Military Applications of Electroplating"
   by—*Dr. Wm. Blum*, U. S. Bureau of Standards, Washington, D. C.

Monday Afternoon, June 8.

Technical Plating Session

1. "Progress Report on the Effects of Polishing on the Protection Value of Plated Coatings"
   by—*Gerald Lux*, A.E.S. Research Associate, National Bureau of Standards, Washington, D. C.
2. "Plating for Selective Carburizing"
   by—*M. M. Thompson*, Director of Research, National Cash Register Company, Dayton, Ohio.
3. "Diffusion of Thin Electroplated Films"
   by—*Dr. Benjamin Lustman*, Research Chemist, Standard Steel Spring Company, Coraopolis, Pa.
4. "Interesting Electroplating Reactions shown by Colored Motion Pictures"
   by—*Frank K. Savage*, Research Chemical Engineer, C. G. Conn, Ltd., Elkhart, Indiana.

Oxide Coatings & Aircraft Plating Session

Tuesday Morning, June 9.

1. "Surface Treatment of Magnesium"
   by—*Dr. J. D. Hanowalt*, Mgr. of Production Control, Dowmetal Div., Dow Chemical Co., Midland, Michigan.
2. "Plating on Aluminum"
   by—*W. J. Travers*, Krome-Alume Co.
3. "Anodizing Aluminum by the Chromic Acid Process"
   by—*L. G. Tubbs*, Mutual Chemical Co.
4. "Metal Finishing for Military Aircraft"
   by—*Julius Teres*, Wright Field, Dayton, Ohio.

Electroplating Session

Tuesday Evening, June 9.

1. "Subject Unannounced"
   by—*Carl E. Heussner*, Chrysler Corp., Detroit, Michigan.
2. "Lead Sulfamate Plating"
   by—*E. W. Schweikher*, Electroplating Div., E. I. DuPont de Nemours & Co., Cleveland, Ohio.
3. "Bright Copper Plating from an Acid Solution"
   by—*Wm. M. Phillips*, Head of Electrochemical Dept., General Motors Research Corp., Div. of General Motors Corp., Detroit, Michigan.
4. "Application of Iron Deposits in the Printing Industry"
   by—*Dr. Vernon A. Lamb*, Bureau of Printing & Engraving, Washington, D. C.
5. "Indium Plating in Practice"
   by—*Dr. Wm. S. Murray*, President of Indium Corp. of America, Utica, N. Y.

Organic Finishing Session

Wednesday Morning, June 10.

1. "Equipment for Application of Organic Finishes"
   by—*E. F. Fry*, DeVilbiss Company, Toledo, Ohio.
2. "Formulation, Application and Availability of Organic Finishes"
   by—*Dr. Chas. A. Lankau*, Chemist, Egyptian Lacquer Co., New York, N. Y.
3. "Military Applications for Organic Coatings"
   by—*Paul Goodell*, C. M. Hall Lamp Co., Detroit, Michigan.
4. "Application of Phosphate Rustproofing in Defense Industries"
   by—*V. M. Darsey*, Technical Director, Parker Rustproof Co., Detroit, Michigan.

21st Annual Joint Meeting of the Buffalo-Rochester Branches, A.E.S.

The Buffalo-Rochester Branches of the A.E.S., will hold their 21st annual joint educational session and dinner dance at the Seneca Hotel in Rochester, N. Y., on Saturday afternoon and evening, April 18th.

The guest speakers for the educational session, which starts at 2:00 P.M., will be: *R. O. Hull*, chemist, E. I. duPont de Nemours & Co. "Physical Methods of Testing Plating Baths".

W. A. Helbig, chemical engineer, Darco Corp. "Recent Developments in the Use of Activated Carbon for Electroplating Solutions".

Gustaf Soderberg, chemist, The Udylite Corp. Topic to be announced.

A banquet will be held at 7:00 P.M. with entertainment and dancing. Everyone is cordially invited to attend.

Milwaukee Meeting

The annual educational session and banquet will be held at the Schroeder Hotel, Milwaukee, Wis., April 25.

The educational session will start at 2 P.M. in the Green Room of the Schroeder Hotel, and the program for the meeting follows:

1. "Some Plating Problems", which will include plating with inside anodes and stripping of deposits. *Gustaf Soderberg*, Udylite Corp., Detroit, Mich.
2. "Silver and Indium Technique", which will be accompanied by a moving picture, showing some of the processes. *Frank K. Savage*, C. G. Conn, Ltd., Elkhart, Ind.
3. "Acid Copper Plating". *Walter Pinner*, General Spring Bumper Div. of Houdaille-Hershey Corp., Detroit, Mich.

The banquet will be in the Crystal Ballroom of the Schroeder Hotel, starting at 7 P.M. There will be entertainment and dancing following the banquet.

Tickets are $3.25 each, and remittances should be made to *Robert Steurnagel, Jr.*, 3924 N. 37th St., Milwaukee, Wis.

New England Branches

The New England Regional Meeting of the Society sponsored by seven New England Branches will be held April 25th at the Highland Hotel, Springfield, Mass.

The educational session will start at 2 P.M. and the dinner and entertainment will be held in the evening as usual.

The Highland Hotel was selected because of its excellent reputation for food, and Publicity Chief, *Jack Costigan*, states that the lobster is particularly good.

Masters' Electroplating Association Party

An informal party, with bowling, dinner, card games and dancing is planned by the Masters' Electroplating Association. In spite of the critical situation in the industry, brought on by priorities and restrictions, the Platers still want relaxation and cheerful activities; hence they invite their friends, with their families and children, to join them in this informal gathering.

The date is the evening of April 18, and the place is the Downtown Bowling Alleys, 23 Park Row, New York City. Tickets at $4.00 each, including everything, may be obtained from the secretary of the Masters' Electroplating Association at 123 William Street, New York.

National Metal Trades Association will hold its 44th Annual Convention at The Biltmore, New York City, on May 19 and 20.

The Galvanizers Committee

Spring Meeting

The Galvanizers Committee, which is sponsored by the American Zinc Institute, is to hold its eleventh meeting at the Hotel Chase in St. Louis, Missouri on Monday and Tuesday, April 20 and 21.

D. A. Russell of Youngstown Sheet & Tube Company who has charge of the program has announced that on Monday morning the Committee will attend the opening sessions of the 24th Annual Meeting of the Zinc Institute when subjects relating to slab zinc production and distribution are to be discussed.

The sessions on Monday afternoon and Tuesday morning will be open only to members of the Committee and their representatives. A representative of the Iron & Steel Branch is scheduled to discuss the War Production Board and Galvanized Products. A round table conference on future market trends will be led by several market development specialists from the steel industry. A new bend testing machine, designed and built under the auspices of a

VULCAN SODIUM STANNATE

Manufactured by

THE VULCAN DETINNING CO.
SEWAREN, N. J.

Under Patents Nos. 1,575,217 and 1,708,392

FOR TIN ELECTROPLATING

SALES AGENT

The R. & H. Chemicals Dep't, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

CHROMIUM PLATING
SCREWS—RIVETS—
WASHERS
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BRASS SHEET
Bronze and Gilding
Processed For Difficult Drawing Bright Finishes
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PLATERS and POLISHERS DATA BOOK

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Originators and Manufacturers of
WONDERBAR, *Pre-Saponified*
BUFFING, POLISHING COMPOUND

special subcommittee headed by *W. R. Shimer* of the Bethlehem Steel Company, will be exhibited and demonstrated at the Tuesday morning session.

Members of The Galvanizers Committee will join with the Institute at a dinner which is to be given at the Chase Hotel on Monday evening, April 20. The present Governing Board of the Committee consists of *Nelson E. Cook*, Chairman—Wheeling Steel Corporation,

B. P. Finkbone — American Rolling Mill Company,

C. K. Lytle—Tennessee Coal, Iron & R. R. Company,

D. A. Russell—Youngstown Sheet & Tube Company,

W. R. Shimer—Bethlehem Steel Company,

J. J. Shuman—Jones & Laughlin Steel Corporation,

C. H. Steele — Steel Company of Canada, Limited.

Electrode

U. S. Pat. 2,275,194. R. R. Sizelove, assignor to Frederick Gumm Chemical Co., Inc., Mar. 3, 1942. An electrode for an electrocleaning bath comprising two superimposed interconnecting grills extending parallel to each other in vertical planes.

Hard Solder

U. S. Pat. 2,274,863. J. Leuser (Germany), Mar. 3, 1942. A soldering alloy resistant to tarnishing essentially comprising 25—85% gold, 2—20% palladium, 5—30% copper, 3—25% cadmium, 0.5—20% silver and 0.1—5% zinc.

Business Items

American Seitz Filter Corp. have announced that the name of this corporation has been changed to *Republic Filters, Inc.* The factory and executive offices are at Paterson, N. J., and the eastern sales offices at 480 Lexington Ave., New York City. The change is merely one of name, and the officers and personnel of the company will be the same.

News from California

BY FRED HERR

Shipment of carload lots of antimony ore by *Antimony Producers Co.* on December 28 marked the development of a new source of this strategic metal in the Lovelock, Nevada, area. Compressor equipment has been installed and mining of ore is reported to be proceeding at several points, with indications said to be promising for persistence of values to depth. The property was recently acquired by the Antimony Products Co. from Miss Alma D. Priester of Los Angeles.

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Reg. U. S. Pat. Off.
Nickel Plating Solution
The one bath especially designed for plating WHITE METAL ALLOYS including ZINC, LEAD and ALUMINUM.

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For stamping and drawing

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These rough-surfaced solid-shaped grains hold unusually well in the glue.

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The Excell Battery Co., has moved to 600 South Fair Oaks Ave., Pasadena, Calif., where enlarged floor area has permitted the increased manufacture of flashlights and batteries to a total volume of 15,000 per day.

The Wire & Metal Manufacturing Co., which in 1941 erected a new building at 5965 Alcoa Ave., Los Angeles, has awarded contracts for a 24,000 sq. ft. addition to the factory, and a 7,200 sq. ft. warehouse. Products made by the company include metal stampings, wire products and light structural articles.

Carleton B. Tibbetts, vice-president of the *Los Angeles Steel Casting Co.* on January 15 was elected president of the Los Angeles Chamber of Commerce. Mr. Tibbetts was president of the Metal Trades Manufacturers Association for seven years.

Pacific Coast Job Platers Send Representative to Washington

Meetings of job shop platers held in Los Angeles and San Francisco early in March culminated in the decision to send a special representative to Washington to discuss with priority officials two subjects of vital importance to job shop platers on the west coast.

A fund of $1000 was raised to finance the trip of *Stanley White* of the *Cadmium-Nickel Plating Co.*, Los Angeles, who will represent the interests of some 400 Pacific Coast job shop platers in the national capitol. Mr. White left Los Angeles by plane for Washington on Sunday, March 8.

He was delegated to represent Pacific Coast job shoppers on two subjects:

1. To attempt to get a six months extension of nickel essential to chrome plating.

2. To attempt to stop issuance of high priority ratings to aircraft factories and other defense work plants for plating room equipment on the ground that many job shop platers, now without defense contracts and threatened with extinction, are available to perform aircraft plating on a subcontract basis.

John Field has opened for business as *The Silvercraft Co.*, at 747 South Hill St., Los Angeles.

C. A. Warnacutt of the *Ducommun Metals & Supply Co.* of Los Angeles was elected vice-president of the Los Angeles Building Material Dealers Credit Association at

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the annual meeting January 7, and was also named to the 1942 board of directors.

Oscar Johnson has opened the *Western Plating Works* at 631 South San Pedro St., Los Angeles.

D. D. Bowman and *M. C. Nieberle* have contracted a partnership under the name of *Douglas Polishing Shop*, 3565½ Whittier Blvd., Los Angeles.

Walter Sundmark, vice-president *Sundmark Supply Co.*, Los Angeles, Southern California representatives for the *Lea Mfg. Co.* of Waterbury, Conn., has enlisted in the Naval Reserve. Affairs of the Sundmark Supply Co. will be handled during his absence by his brother, *Roger Sundmark*, president of the firm.

The foundry division of *Menasco Mfg. Co.*, Los Angeles, was sold to the *R. H. Osbrink Mfg. Co.*, effective March 2, which leaves the Menasco organization free to concentrate its entire attention on the production of hydraulic landing gear struts in its Burbank, Calif. plant.

For the past several years the Menasco foundry has been producing non-ferrous castings by the Antioch process, and more recently has been manufacturing aluminum sand castings. The property consists of 2½ acres of land and 41,000 square feet of buildings.

The Maritime Brass & Bronze Works has been established at San Pedro, Calif., by *A. N. Thomas* and *J. A. Robinson*.

R. N. Eldred, manager of the Pacific Division, *R.&H. Chemicals Division, E. I. DuPont DeNemours & Co., Inc.*, has returned to Los Angeles from attendance at a three-day meeting of the electroplating division of the company at Cleveland, O.

Gardner Champ, Phoenix, Ariz., manager of *Turco Products, Inc.*, was in Los Angeles on a business trip early in March and attended the March 11 meeting of Los Angeles A.E.S. Branch.

Hard Chrome Engineering Co., are now located in their new building at 1717 East Slauson Ave., Los Angeles, Cal.

Rolock, Inc., are now located in their new, modern building at 1350 Kings Highway East, Fairfield, Conn. The company manufactures welded baskets and crates for pickling, degreasing, anodizing, annealing, cyaniding and all metal working processes.

The Roberts Rouge Company, Stratford, Connecticut, have acquired additional land which now makes five and a half acres adjacent to their modern plant for producing a complete line of buffing compounds for all purposes.

With a substantial natural growth of well placed trees close to a running brook and with considerable landscaping, this industrial site will be among the most attractive in the Bridgeport manufacturing area.

Visitors are cordially invited.

Foster D. Snell, Inc. Expands Laboratory Facilities

Increasing laboratory space by more than fifty per cent in the past year, Foster D. Snell, Inc., 305 Washington St., Brooklyn, N. Y., have added substantially to their facilities for rendering consulting and research services. Aside from additional unit laboratories, the space is devoted to an enlarged constant-temperature room, additional photographic and photomicrographic equipment, another animal room which permits the handling of almost double the number of experimental animals, an enlarged library and additional facilities for handling sensitivity tests on human subjects.

Present plans call for another laboratory outside of New York in the near future devoted solely to furniture and furniture finishes.

The Plating and Rustproofing Association of Michigan Begins Fifth Year

New Officers Elected

The Plating and Rustproofing Association of Michigan, incorporated 1938, began its fifth year. The annual meeting was held Saturday, March 7, 1942 at the Hotel Statler, Detroit, Michigan. *Henry J. Bock* of the Auto City Plating Co. was elected to the Board of Directors in place of Mr. Adelsperger of the same company.

Charles Erdman

At the meeting of the Board of Directors, subsequent thereto, *Charles Erdman*, President of the Central Plating Co. succeeded to the office of President for the year 1942-43, in place of *Robert L. Reed* and *James C. Nankervis*, President of the Advance Plating Co. was elevated to the office of Vice-President, while *Frederick R. Bolton* was reelected for the fifth year as Secretary and Treasurer. *Raymond M. Shock* was elected as the Assistant Secretary and Treasurer.

The Association had a very busy year as most Trade Associations have had, delegations having been set to Washington and at the present time a pooling organization is being set-up in cooperation with the War Production Board and for the purposes of securing War contracts in this area.

The Association continues to grow, having added a number of new companies in the recent months and does substantially represent the industry in this area today.

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Supply Prices, March 27, 1942

Anodes

Prices are f.o.b. shipping point on quantities of from 500-999 lbs. for copper, brass and zinc. For nickel, prices are for quantities from 500-2,999 lbs.

COPPER: Cast, elliptical, 15" and longer	25⅛c. per lb.	ZINC: Cast, 99.99, 16" and over	16¼c. per lb.
Electrolytic, full size, 22⅞c; cut to size	22⅞c. per lb.	NICKEL: 95-97 cast, elliptical 46c. per lb., 99% plus cast 47c.; rolled, depolarized	48c. per lb.
Rolled, oval, straight 15" and longer 23¼c. per lb.; curved	24¼c. per lb.	SILVER: Rolled, .999 fine per Troy oz.	38c. per oz.
BRASS: Cast, 80-20, elliptical, 15" and longer	23⅝c. per lb.		

Chemicals

These are manufacturers' quantity prices and based on delivery from New York City.

Acetone, C.P., drums, l.c.l.	lb.	.09-.178
Acid, Boric tech., 99.5% gran., bbls.	lb.	.063
Chromic, 99%, 100 lb. drums, l.c.l.	lb.	.18¼
Hydrochloric (muriatic) tech., 20°, carboys, wks.	lb.	.0270
Hydrochloric, C.P., 20°, bottles	lb.	.19
Hydrofluoric, 30% bbls.	lb.	.06-.06½
Nitric, 36°, carboys 1-9, wks.	lb.	.0595
Nitric, 42°, carboys 1-9, wks.	lb.	.0745
Oleic (Red Oil), distilled, drums	lb.	.143
Oxalic, bbls. l.c.l.	lb.	.125
Stearic, distilled, double pressed, bags	lb.	.1680
single pressed, bags	lb.	.1625
triple pressed, bags	lb.	.1985
Sulphuric, 66°, carboys 1-9, wks.	lb.	.0245
Alcohol, Amyl (Fusel oil, ref'd), l.c.l., drums	lb.	.18-.18½
Butyl-normal, l.c.l., drums	lb.	.13½-.168
Denat., S.D. #1, 190 pf., 1-18 drms., wks.	gal.	.67
Diacetone, tech., drums, l.c.l.	lb.	.12-.15
Methyl, (Methanol), 95%, drums, l.c.l.	gal.	.37
Propyl-Iso, 99%, drums, l.c.l.	gal.	.47
Propyl-Normal, drums, wks.	gal.	.67-.70
Alum, ammonia, granular, bbls., works	lb.	.04
Potash, granular, bbls., works	lb.	.0425
Ammonia, aqua, 26°, carboys	lb.	.05¼
Ammonium, chloride (sal-ammoniac), white, granular, bbls., wks.	lb.	.0675
Sulphocyanide (thiocyanate), pure, crystal, kegs	lb.	.55
Sulphocyanide (thiocyanate), tech., kegs	lb.	.40
Antimony Chloride (butter of antimony), sol., carboys	lb.	.17
Barium Carbonate, pptd., bags, l.c.l., works	lb.	.03
Benzene (Benzol), 90%, drums, works	gal.	.20
Butyl Lactate, drums	lb.	.265
Cadmium Oxide, l.c.l., bbls.	lb.	.95
Calcium Carbonate (Pptd. chalk), c.l., wks.	lb.	.02⅞
Carbon Bisulphide, l.c.l., 55 gal. drums	lb.	.05¾
Carbon Tetrachloride, l.c.l., drums	gal.	.80
Chromic Sulphate, scale, 100 lb. drums	lb.	.45
Cobalt Sulphate, drums	lb.	.71
Copper, Acetate (verdigris), bbls.	lb.	.26
Carbonate, 52-54%, bbls.	lb.	.16½
Cyanide, Tech., 100 lb. bbls.	lb.	.34
Sulphate, 99%, crystals, bbls., 1-5	lb.	.0535
Cream of Tartar (potassium bitartrate), gran., kegs	lb.	.58½
Crocus Martis (iron oxide) red, bbls.	lb.	.03¼
Dextrin, white, bags, F.O.B. Chicago	lb.	.0395
Dibutyl Phthalate, drums, l.c.l.	lb.	.215-.235
Diethylene Glycol, drums, l.c.l., works	lb.	.155
Emery (Turkish)	lb.	.08
Ethyl Acetate, 85%, l.c.l., drums, works	lb.	.125-.135
Ethylene Glycol, l.c.l., drums, works	lb.	.15½-.18½
Monoethyl ether, dms., l.c.l., wks.	lb.	.15½-.16½
Gold, Chloride, yellow, bottles	oz.	$19.25
Cyanide, potassium 41%, bottles, wks.	oz.	$14.20-$14.95
Gum, Arabic, white, powder, bbls.	lb.	.33-.35
Hydrogen Peroxide, 100 volume, carboys	lb.	.16-.18½
Iron Sulphate (Copperas), cryst., bbls., 1-4 wks.	lb.	.02
Lead, Acetate (Sugar of Lead), crystals, bbls.	lb.	.13¼
Oxide (Litharge), com., powdered, bbls.	lb.	.09
Magnesium Sulphate (Epsom Salts), tech., bbls.	lb.	.019
Mercury Bichloride (Corrosive Sublimate), crys.	lb.	$2.39
Mercuric Oxide, tech., red, powder, bbls.	lb.	$3.11
Nickel, Carbonate, dry, bbls.	lb.	.36-.36½
Chloride, bbls.	lb.	.18-.20
Salts, single, 425 lb. bbls.	lb.	.135-.145
Salts, double, 425 lb. bbls.	lb.	.135-.145
Paraffin, refined, bgs., 123-125 a.m.p., c.l.	lb.	.0520
Perchlorethylene, drums, l.c.l.	lb.	.08½
Phosphorus, red, cases	lb.	.44
yellow, cases	lb.	.23-.25
Potash, Caustic, 88-92%, flake, drums, works, c.l.	lb.	.07¼
Potassium, Bichromate, crystals, casks	lb.	.10
Carbonate (potash) calc., wks., drums	lb.	.06¾
Cyanide, 94-96%, dom. dms., wks.	lb.	.55
Pumice, ground, 1½ F. & coarser, bbls., wks.	lb.	.04½
Quicksilver (Mercury), dom. 76 lb. flasks, net	flask	$191-$193.
Rochelle Salts, crystals, bbls.	lb.	.44
Rosin, gum, D bbls., dock	lb.	.0355
Silver, Chloride, dry, 50 oz. lots	oz.	.38⅞
Cyanide, 100 oz. lots	oz.	.34
Nitrate, 100 oz. lots	oz.	.27⅛
Sodium, Carb. (soda ash), light, 58%, bags	lb.	.0213
Cyanide, 96%, dom. 100 lb. drums	lb.	.15
Hydroxide (caustic soda) 76%, flake, l.c.l.	lb.	.0490
Hyposulphite, crystals, bags, wks.	lb.	.0250
Metasilicate, granular, 1-9 bbls.	lb.	.0355
Nitrate, rfd., gran., bbls., wks.	lb.	.040
Phosphate, tribasic, tech., bbls., wks.	lb.	.038
Pyrophosphate, anhydrous, bags, l.c.l.	lb.	.0660
Sesquisilicate, 1-9 drums	lb.	.0430
Stannate, drums	lb.	.365
Sulphate, anhydrous, bbls., works	lb.	.0240
Sulphocyanide, drums	lb.	.55-.65
Sulphur, Flowers, U.S.P., bbls., l.c.l. mine	lb.	.041
Tin Chloride, crystals, kgs.	lb.	.39-.39½
Toluene (Toluol), 2°, ind., drums, works	gal.	.33
Trichlorethylene, drums, l.c.l., zone 1	lb.	.08½
Tripoli, air floated, bgs., c.l., wks.	ton	$21.00
Wax, Bees, white, bleached, slabs, 1-5 cases	lb.	.61
Bees, yellow, crude, Brazil, 100 lbs.	lb.	.50
Carnauba, refined, bags	lb.	.85
Montan, bags	lb.	.45-.46
Spermaceti, blocks	lb.	.26-.27
Whiting, precipitated, bags, l.c.l.	ton	$18.-$22
Xylene (Xylol), ind., returnable drums, works	gal.	.32
Zinc, carbonate, tech., bbls.	lb.	.20
Cyanide, 100 lb. kegs	lb.	.37
Chloride, tech., granular, drums, c.l., wks.	lb.	.08
Sulphate, crystals, bbls., l.c.l.	lb.	.039

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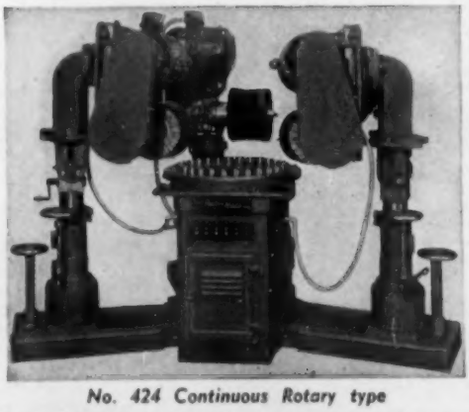

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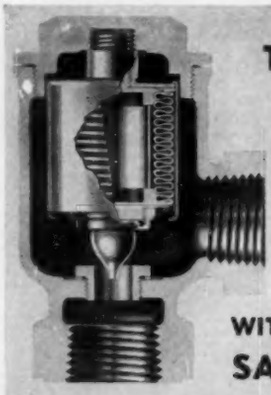

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